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PREPARING FOR THE EXPORT LAMB SEASON.

F. L. SHIER,

Agricultural Adviser.

The production of export lambs of prime quality is of vital importance in placing this industry on a firm footing and establishing a reputation on the London market for quality meat. Last season many consignments from this State brought outspoken praise from authorities overseas. This State exported last season approximately 280,000 lambs, of which approximately 29 per cent. were first-grade. In 1937 82 per cent. of the lambs from the Avondale Research Station treated for export graded first-grade, whilst many prominent producers had similar returns. These figures speak for themselves and need little comment. It is felt, however, that the State's figure can be improved considerably.

A good reputation will assist materially in the disposal of our lambs at satisfactory prices on the overseas market, and this is of greater importance should the market ever become over-supplied and more discrimination be exercised by the buyers. A good name cannot be attained except on quality.

The production of prime quality lambs depends mainly on two factors, firstly breeding and secondly feeding. These two factors are equally important, and if either one is not of a high standard, then a large percentage of first-grade lambs cannot be expected.

It is not proposed to discuss at this stage the merits and demerits of the different breeds and crosses; this factor has already been determined for the coming season's drop. It is proposed, however, to suggest some points for consideration, such as feeding and care and attention, which it is hoped will assist in the placing on the market this year of the greatest possible number of first-grade lambs.

Feeding the Ewe.

Whilst it has been shown that an improving state of nutrition is the most favourable for obtaining a high percentage "drop," it is generally not well known that during the bulk of the gestation (in lamb) period the ewe has very little extra food requirements above maintenance. It is only necessary to keep her in good healthy store condition. During the last third of pregnancy, however, the ewe has definite extra food requirements, firstly to provide for the developing foetus, and

secondly to stimulate the growth of the milk-producing tissue of the udder. The lamb in the first three months of its life depends almost entirely for its growth and development on the milk supply of its mother. The digestive system of the young lamb is not sufficiently developed to allow it to deal with harsh bulky foods.

It is, therefore, apparent that an adequate supply of highly nutritious food rich in flesh-forming and milk-producing material, *i.e.* protein, should be available to the ewe for the last four weeks of pregnancy and from the time the lambs are dropped until they are marketed.

In the case of the Merino, and lambs other than those for export, a steady rate of growth through the winter, followed by good natural feed conditions during the spring, is sufficient to ensure a well-grown weaner. With such lambs the short period of somewhat slow or retarded growth is counterbalanced by the accelerated later growth when the feed becomes plentiful in the spring. With the export lamb the position is different. Prime quality, showing good bloom and "finish," can only be ensured where the lamb is growing at a maximum rate throughout the whole period. Slow growth in the early life will be reflected adversely in the final product. An abundance of good feed is, therefore, of profound importance for the production of prime quality export lambs.

Supplementary Feeding.

Where farmers have mated so that lambs can be expected before the green feed arrives it is essential that provision be made for supplementary feeding. Concentrates, such as oats or peas, with good quality hay, or, better still, meadow hay made from Subterranean Clover pastures, should be supplied to the lambing ewes until a bulk of green feed is available.

Green Feed Crops.

Preparation should also be made for green crops such as oats, rape or barley, or mixtures of these crops. Well prepared fallow, preferably on the lighter soil types, will permit of areas of green feed crops being sown which will germinate and get away well after the first rains. Crops of this nature quite frequently make excellent growth and before sufficient rain has fallen to produce germination and growth on pastures.

Renovation and Top-Dressing of Pastures.

Good pastures, especially of the Subterranean Clover type, are excellent in supplying a highly nutritious protein diet so valuable for milk production. Every effort should be made to induce early germination and growth before the cold weather conditions have set in. Suitable soil renovation will produce a loose surface and allow the early rains to penetrate and so encourage early germination. Adequate top-dressing with superphosphate is also essential. This stimulation of the early growth of pastures is also valuable in strengthening them and preventing the serious effects of insect pests, such as lucerne flea and red mite. Pastures which germinate under cold winter conditions suffer much more from these pests.

Care and Attention at Lambing Time.

At lambing time special and frequent attention should be given to the ewes. They should preferably be pastured in paddocks containing shelter belts on high and dry conditions. Daily inspections should be made and, where required, attention given to those ewes experiencing lambing difficulties. If possible, at weekly intervals the ewes which have lambed, together with their lambs, should be worked off the flock and pastured separately on the best pastures or special crops. The lambs should be tailed and marked when two to three weeks old. This procedure

should be carried out at similar intervals throughout the season, so that no lambs become too old before being treated. If the lambs are too old and big they will suffer a setback following the operation.

Marketing.

The age and size at which to market the lambs always presents some difficulty to the farmer. The weight should not be the main consideration in deciding when to market. Of more importance is the quality and "finish." Large framed lambs may not be sufficiently "finished" at 30-32 lbs., and would consequently be graded second-grade. Such a lamb could probably be held for further time to advantage and grade first-grade. In general, conformation and "finish" should be the main guides in determining when to market. Marketing should be carried out at frequent intervals, as lambs after they reach their top are likely to go off and lose their bloom and "finish."

The most profitable weight at which to market the lamb is also a question which is open to much discussion. Frequently overseas reports indicate that the lamb most favoured is the light weight one. Careful examination of the returns from the Avondale Research Station have indicated that the 8's (37-42 lbs.) have realised 1s. to 1s. 6d. per head net at the works more than those in the 2's grade (29-36 lbs.). Those in the D grade (28 lbs. and under) have realised considerably less than the 2's and 8's. Moreover, in practice lambs which would dress in this grade (D) are generally not sufficiently "finished" to be marketed. The heavy grade 4's (43-50 lbs.) have generally realised about the same, to slightly less, than those in the 8 grade and indicate that it is not profitable to allow the lambs to reach this weight.

Whilst market fluctuations may cause a revision of this question in future years it would appear advisable to aim at a dressed weight of about 36 lbs. tending towards the heavier side but not above 42 lbs. Live weight figures on the farm for these dressed weights would be approximately 75-85 lbs.

Although it is not necessary to weigh all the lambs on the farm it is a good practice to weigh a few from time to time as the weights of some lambs are often very deceptive. Towards the end of the season it is often apparent that some lambs will not be ready for export before the grass seeds appear. Such lambs should be shorn and held for two or three weeks or more before marketing, when any skin or bruise blemishes which have occurred during shearing will have disappeared.

Young lambs are very tender and easily bruised and every care should be exercised when handling and trucking them so as to avoid this bruising, which results in lower grading and consequently reduced returns. Mr. Davenport, Agricultural Adviser, drew attention to this question in the issue of this Journal of June, 1937, and stated that "the most common causes of bruising were catching and picking up the lambs by the wool, hitting or prodding them with a stick or hard object; when drafting or loading allowing them to become overcrowded in a confined space as when passing through a race in the yards or into a truck; the use of a dog without a muzzle (a slight nip will leave a tell-tale bruise)." Avoid all these practices.

In conclusion it is not suggested that the adoption of these various points will bring the State's percentage of first-grade lambs up to a figure like 75 or 80. The question of suitable sires and the general absence of large numbers of crossbred ewes will mitigate against this at the present time. It is felt, however, that there is considerable room for improvement in the feeding, general care and management which, if adopted, can materially raise the level of the quality of the lambs exported from this State.

IRRIGATED PASTURE COMPETITION.

RESULT OF FIRST YEAR'S INSPECTION—1937.

A. R. C. CLIFTON,
Officer in Charge of Irrigation.

H. G. ELLIOTT,
Agricultural Adviser Dairy Branch.

The Competition was inaugurated by the Harvey Agricultural Society and embraces the whole of the irrigation areas extending from Waroona to Dardanup.

The object of the Competition was to stimulate interest and to demonstrate methods proved successful in the management of irrigated pastures, particularly the necessity for adequate drainage.

The Competition will be conducted for a period of three years and will be judged twice annually. Cuming Smith & Mt. Lyell Farmers Fertilisers Ltd. have generously donated a trophy valued at 10 guineas for the winner at the conclusion of the Competition. Each Agricultural Society also is awarding an annual prize for the winners in their area.

The results of the two inspections which were carried out during the months of June and December have been combined and the results of the first year's inspection are given in the following table:—

Competitor.	Drainage and Irrigation Lay-out and Condition. (20)	Mixture. (20)	Sward and Uniformity. (20)	Condition of Pasture According to Age. (20)	Management. (20)	Total. (100)
C. E. Edwards, Waterloo (1)	17	16½	16¾	18½	11¼	80
E. Holthouse, Harvey (2) .	12	17½	17½	17	8½	72
J. Salarian, Waroona (2) .	13	16½	15¼	14	11¾	70½
C. E. Edwards, Waterloo (2)	13½	15¾	15½	16	9¼	70
A. E. Jackson, Roelands	13½	16¼	14¾	15	9¼	68¾
L. Temple, Harvey (2) ..	13	16½	13½	14½	10½	68
L. Temple, Harvey (1) ...	13	16¼	13	14½	10¾	67½
T. P. Harris, Waterloo ..	11¾	15¼	14¾	14½	10	66¼
J. Salarian, Waroona (1) . .	10¼	15	15¼	13	10¾	64¼
F. Reeves, Brunswick .	11½	14¼	13¼	13	10	62
E. Holthouse, Harvey (1) ...	13¼	16¾	11½	12½	6½	60½
S. Bowers, Brunswick	12	14	11¾	12	9¾	59½
T. Tyrell, Waterloo . .	11¼	13½	11	9½	8	53¼
H. Piggott, Brunswick ...	10¾	13½	10	11¼	7	52½
C. F. Giblett, Harvey .	11½	14	10¼	10½	6	52¼
L. and C. Hynes, Waterloo (2)	10½	13¾	10¼	9½	6	50
W. C. Edwards, Burekup	13½	10¾	9	8½	8	49¾
W. Noakes, Brunswick ...	9½	12¼	11	10	6½	49¼
L. and C. Hynes, Waterloo (1)	11¼	14	10¼	9	4½	49
J. Hynes, Waterloo	8¾	13	10¾	10	5½	48
F. J. Beecher, Harvey . .	13	8½	8	7½	8½	45½

The winners of the annual prizes awarded by the Agricultural Societies conducting this competition are as follows:—

Brunswick Agricultural Society: Mr. C. E. Edwards, No. 1 entry.
Harvey Agricultural Society: Mr. E. Holthouse, No. 2 entry.
Waroona Agricultural Society: Mr. J. Salarian, No. 2 entry.

It is evident from the number of entries received that the settlers in these districts are keenly interested in the development of irrigated pastures. Generally, the pastures exhibited were good, some of them being capable of carrying approximately 1 cow to the acre. These results have been achieved only by careful attention to watering, manuring, and the judicious grazing of the pasture.

One of the most important features noted was the fact that good strains of pasture grass and clover seeds were used in every case.

Another important factor was that in many instances the mistake was made of laying down pastures too soon before the land was properly prepared. For an important crop like permanent pastures which, with proper management, will be reproductive for many years, it is obvious that thorough and very careful preparation is essential to obtain the best results. It is recognised, of course, that farmers generally have had very little time to fit their land properly for irrigation, and it is particularly interesting to note the successive improvements of individual farmers by comparing the layout of their initial irrigated pastures with the one sown at a much later date.

The general application of fertiliser per acre had a tendency to be on the low side. Some of the farmers, however, are applying up to 6 cwts. of fertiliser in two or three applications per annum. On an average 3 to 4 cwts. of superphosphate are being applied in two applications.

At the time of the first inspection it was noted that—

The general management was at fault in one or more of the following: Drainage, Irrigation (furrows too wide apart), Grazing, Fertilising and Renovation. Many entries indicated that more attention to drainage is essential if the productivity of the pasture is to be maintained. This condition is obviously more noticeable where the development is comparatively recent and farmers have concentrated on bringing their land under irrigation and have so far only provided an inadequate superficial system of drainage.

In some instances inadequate drainage is combined with poor pasture management, such as overgrazing, faulty technique in the application of water, and the excessive crowning of the lands between water furrows. Where such conditions prevail bare patches sometimes appear, more particularly along the crowns of the lands and towards the end of the irrigation season, in extreme cases, salt becomes sufficiently concentrated so as to be seen on the surface. Although these bare patches may be directly due to the accumulation of salt which is readily dispersed by the winter rains if drainage is provided, proper irrigation practice which necessitates a correction of the above mentioned faults is known to prevent its appearance.

The results of the first year's inspections showed that -

Generally, the pastures are not grazed efficiently, being rather over-grazed during the winter months and under-grazed during the spring months. This was evident by the bareness and opening of the pastures at the time when grass production is at its lowest ebb, and the tufting and seed head production of the paspalum during the period when peak production is taking place. More attention could be given to the topping off of the pastures with a mower during the periods of high production.

Insufficiency of renovation by means of scarifiers or pasture renovators was also very noticeable, and the lack of efficient harrowing to break up "cow pats" was evident to a marked extent.

The majority of the pastures exhibited consisted of paspalum and white clover with or without perennial rye grass. In some instances, however, cocksfoot had been incorporated. Subterranean clover was showing to some extent during the flush period.

Some of the pastures showed excellent growth and vigour and were comparatively well managed, while the layout indicated a considerable amount of work in preparing the land and making provision for irrigation.

The main objective in irrigating should be to apply the water uniformly and economically to the land. This means a thorough and careful preparation before seeding. It was not uncommon to note paddocks spoilt by a claypan or two or a slight depression which could have been simply graded prior to seeding, whereas this condition is the cause of trouble in waterlogging and excessive waste of water.

Very little alteration had been made between the two inspections with regard to the irrigation channels, furrows and drains.

The furrows vary from 4-10 chains in length, the distance apart being from 7½-21 feet, the average of the latter being 12 feet and the average length 7 chains.

The winning pasture exhibited by Mr. C. E. Edwards as his No 1 entry was sown at the end of November, 1936, on an old pasture paddock which consisted mainly of subterranean clover and annual minor grasses.

Prior to sowing, the land had been graded and ploughed flat with the result that the contour of the paddock was excellent. It is provided with watering furrows 7½ feet apart and 6 chains long, these furrows being connected to a head furrow parallel to the head ditch, enabling economical control of the watering. At the outlet ends the furrows were connected to a tail water furrow, formed parallel with the drain and connected to it at suitable points, thus reducing loss of water due to run-off when irrigating, and at the same time providing adequate winter drainage.

The paddock was well drained, being provided with a cut-off on the top end and an outlet drain on the bottom end, and although the latter could be deeper it was being well maintained. The extent of the area sown was 4 acres.

The mixture sown was certified perennial rye grass 5 lbs. per acre, paspalum 2 lbs. per acre, and certified New Zealand white clover 1½ lbs per acre.

One bag of superphosphate per acre was used at seeding, and 1 bag per acre again in February and May.

During the summer, 1936-37, approximately four weeks elapsed between each watering. This season, however, the interval between watering is three weeks.

The early grazing was carried out with sheep, and dairy cattle were only allowed to graze on it between waterings when the surface was dry.

At the time of first inspection there was approximately a 95 per cent. cover consisting of about 80 per cent. white clover, the balance being perennial rye grass with a small amount of paspalum. Practically no weeds were evident but a little couch grass was noticeable. This undoubtedly was the best pasture for its age at the time of inspection.

The patches which were showing the least amount of cover were where the subsoil had been exposed due to heavy grading. It was noticeable, however, that a decided increase in cover had taken place during the short interval between the two inspections of these areas.

The pasture exhibited by Mr. T. P. Harris was originally sown with paspalum and white clover during 1935. At the time of first inspection, it was showing a considerable quantity of couch with a ground cover of approximately 90 per cent., it being rather badly grazed and showing the effects of excessive winter water.

More adequate drainage has been carried out and the area has been more efficiently fertilised. This plot showed the most marked improvement of any at the time of second inspection, when there was practically a full ground cover of

paspalum and white clover which had been grazed very well and the paspalum prevented from running to seed head.

An interesting feature on this property was an attempt to overcome the inadequate preparation prior to seeding by omitting the grading of the land. Pasture sods taken from a drain cut after seeding have been placed in a typical "clay pan" with the result that the depression has been completely filled and is producing a good mat of pasture. This is practically the only way of overcoming this type of defect after seeding, but it is much more costly than doing some grading prior to planting.

In some cases scalding of the pastures had occurred after the first watering, this being due to the lodging of the water too long in the irrigation furrows, more particularly where excessive ridging of the land had been adopted in the layout.

In one instance considerable damage had been caused to the pasture through not watering early enough. This reduced the area of grazing considerably, as there were large areas completely scorched off by the dry conditions.

NOTES ON THE LATE TALLAROOK STRAIN OF SUBTERRANEAN CLOVER.

H. G. ELLIOTT,
Agricultural Adviser, Dairy Branch.

As the name indicates, this variety originated in Victoria and is classified as a late strain, having approximately the same growing season as the Wenigup or Western Australian late strain.

The Late Tallarook strain has relatively short primary runners, the plants form a dense, compact mat with a high proportion of leaf to stem. The plants tend to remain in the rosette stage much longer than any of the other strains and form their runners and flowers much later than the mid-season strains.

For the past two seasons it has been growing experimentally at the Denmark Research Station and Brunswick with outstanding results.

At the Denmark Research Station where Lucerne Flea and Red Mite infestation is particularly high, other varieties and strains of clovers, grasses and fodder plants were badly attacked, whereas the Late Tallarook strain was only slightly attacked. Similar results were obtained at Brunswick.

The following description of this strain may be of value. It has a pale green calyx and a white corolla, while the leaves are larger than the other types with white crescent and black flecks.

In the higher rainfall areas of this State, this variety should do particularly well on account of its lengthy period of green life, high production and seed formation, marked resistance to red mite and lucerne flea, and its reputed marked palatability.

The Department of Agriculture is conducting further trials with this and other strains of Subterranean Clover in various districts.

The Victorian Department of Agriculture is certifying the Late Tallarook strain of Subterranean Clover and the seed can be obtained commercially.

CARE IN CRUTCHING.

HUGH MCCALLUM,
Sheep and Wool Inspector.

One of the most efficient methods of combating the blowfly is to ensure good crutching. The discolouration about the hindquarters is due to accumulation of dirt in the long wool. This should be removed by crutching as it acts as an ideal breeding ground for the blowfly. Crutching should be done as often as necessary. A systematic mass crutching should be aimed at instead of dealing with an odd sheep in the paddock as is often the practice.

The actual operation should be started by clearing the wool from behind the udder and between the hind legs. This section is done with the sheep sitting on its haunches and having its back leaning against the closed legs of the shearer. For the next part, the sheep must be laid on one side and the wool removed from the back of the lower leg and just beneath the tail. The sheep is then turned on the other side and the opposite back leg is treated likewise.

It is advisable to take off a narrow strip of wool from just above the tail. The finished job, looked at from behind, takes the form of an inverted "U" running from hock to hock over the tail. It is wise to slope off the wool between the short and long parts and not leave a distinct ridge of overhanging wool to get wet and dirty and so attract more flies.

Great care should be taken of pregnant ewes which should, on no account, be carried from the pen. It is advisable to take the utmost care of them when going through gateways and when turning. When crutching there is no necessity to lean on the sheep with the knee or to press heavily on the flank with the fist. The ultimate results of handling ewes roughly are premature births, malformations and dead lambs.

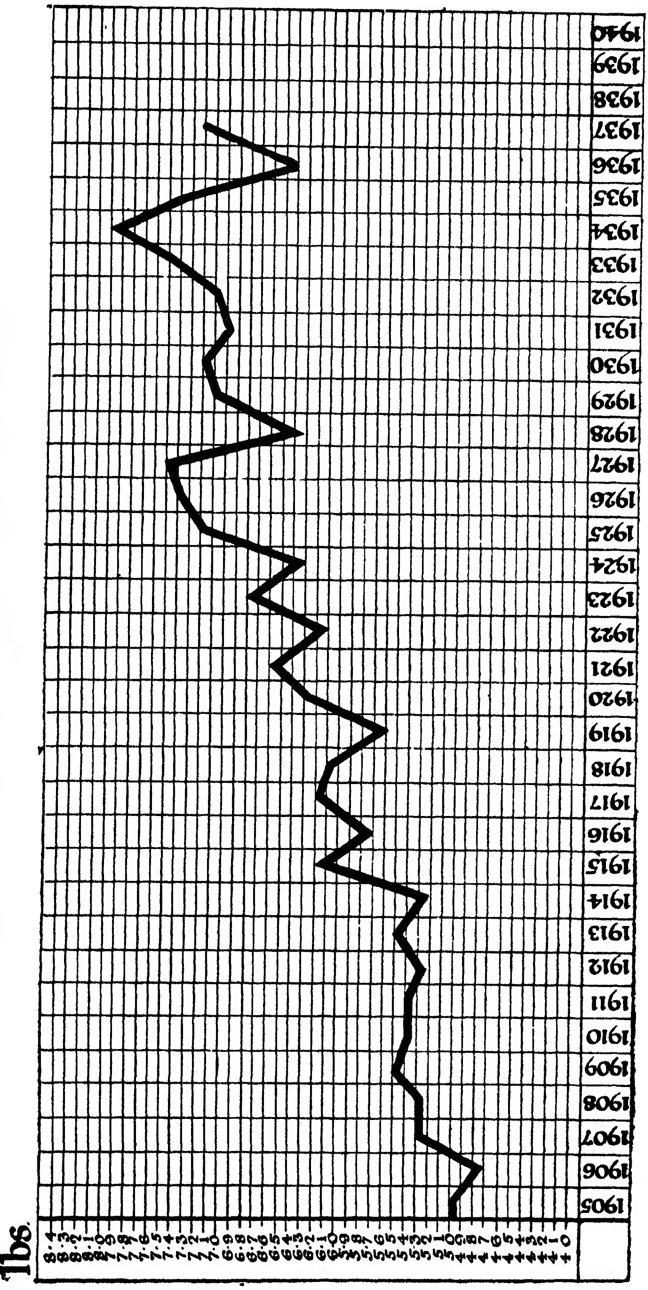
Correct method. Incorrect method.

Many flock-owners crutch their high-grade ewes in a standing position, one person holding the sheep and another handling the shears. By this method there is no possibility of the lamb being turned—the standing position may be much slower but it is certainly the safest method under these circumstances.

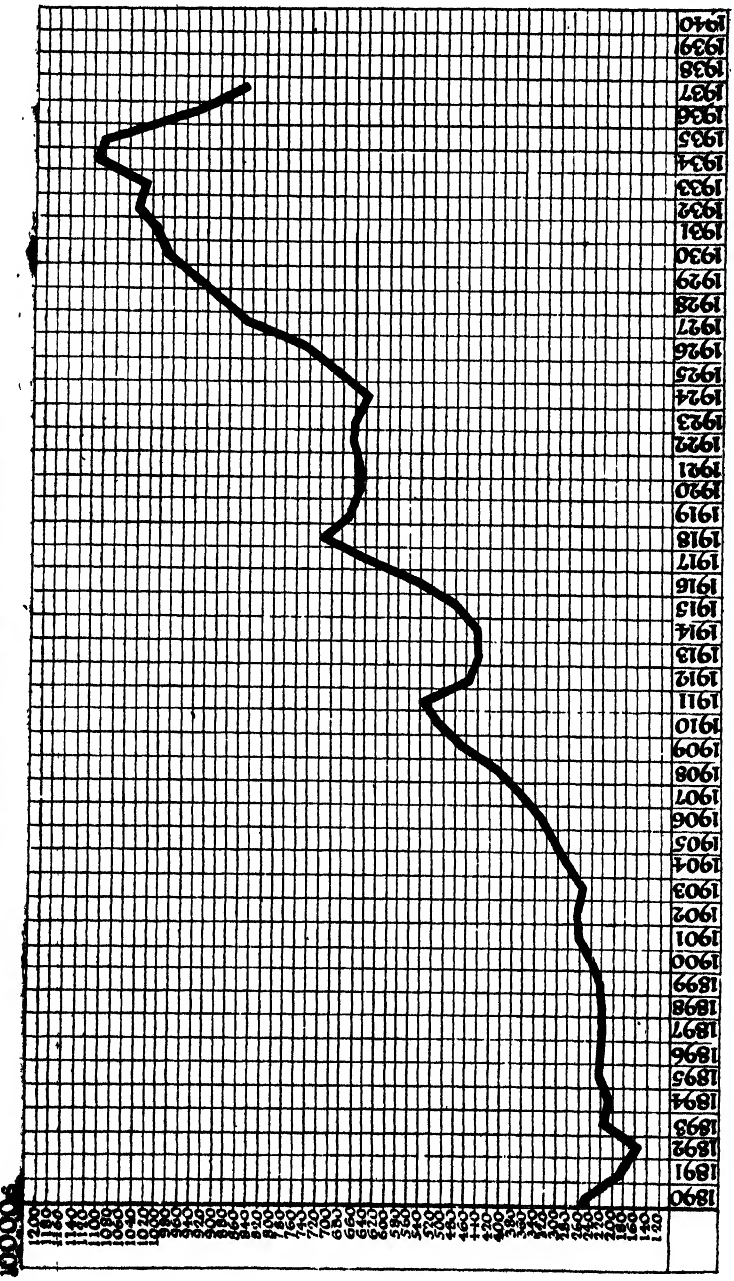
Another benefit derived from crutching is the saving of wool. Through neglect of crutching sheep regularly and correctly a considerable poundage of good wool is wasted at shearing time on account of the large percentage which is stained.

Briefly, then, crutching helps against blowfly, saves wool and, though not previously mentioned, is an assistance to lambing and lamb feeding.

AVERAGE WEIGHT OF GREASY WOOL PER FLEECE.



SHEEP IN WESTERN AUSTRALIA.



FOOT ROT IN SHEEP.

A. McK. CLARK, L.V.Sc.,
Chief Veterinary Surgeon.

Foot rot in sheep and cattle has become particularly prevalent in the South-West portion of the State owing, firstly, to intense pasture development, and secondly, to the neglect on the part of the owners to recognise the disease in its early stages and adopt adequate control measures. This disease exists in all countries where pastures are luxuriant and land is moist. It does not cause great economic loss provided correct control measures are systematically exercised. The only loss in this direction is sustained through loss of condition in sheep and the cost of constant attention.

Foot rot can be recognised in its first stages by lameness. On closer examination a red discolouration of the skin occurs, particularly between the hoofs. Later there is a swelling of the affected tissue and an oozing of clear yellow fluid. An offensive odour develops and the hoof becomes soft, spread and turned upwards; that is, an extra growth of hoof occurs and it becomes, in consequence, spongy and malformed. Sheep may even be seen at this stage eating on the knees.

Prevention.—Although the disease may be termed infectious there is some predisposing influence which must be present. This is due apparently to moisture over a prolonged period as sheep in reasonably dry areas are not affected. In heavy rainfall areas Merino sheep should be avoided as this type is prone to foot rot. The English breeds should be introduced as these have a greater resistance to this infection than the Merino.

Treatment.—Early recognition of foot rot is the greatest advantage in control. When the disease is discovered in a flock all the sheep should be carefully examined and any showing lameness should be separated off from the rest. The former should be placed in a small paddock as constant attention is needed. Each should be closely examined and any loose horn cut away from the hoof and the hoof trimmed up generally. Having done this the sheep should then be placed in a foot bath solution. They should not be walked through quickly but held in the solution for about one hour. This treatment should be done several times at two day intervals. The portion of the flock in which no disease is apparent should be passed occasionally through this solution. It will be necessary, therefore, to construct a concrete foot bath. Foot rot cannot be successfully combated unless an adequate foot bath is used. This bath should be at least six inches deep, 12 inches wide and long enough to hold about fifty sheep. The bath should be filled to about three inches.

The Solution.—Bluestone is effective and cheap. Foot rot can be effectively controlled with this drug. Its use is recommended in a 5 per cent. solution; that is ½ lb. bluestone dissolved in 1 gallon of water. A stronger solution than this has a tendency to burn the tissues of the feet and cause extreme damage. Formalin is also efficacious in a 2 per cent. solution. The same may be said about this that a stronger solution than 2 per cent., apart from being expensive, may damage the feet.

It may be necessary in extreme cases to give individual treatment to affected animals. In such cases, after paring the feet, the hoof should be dressed with a solution composed of a mixture of picric acid 4 ounces, methylated spirits 1 gallon. Apply with a brush. Also another solution may be used composed of resin 2½ lbs. dissolved in 1 gallon of turpentine and then add ½ pint of monsol. Stir vigorously until a uniform mixture is obtained. Apply with a brush.

Should one desire to use formalin for the purpose of treatment it should be mixed with glycerine in the proportion of 1 pint of formalin in 9 parts of glycerine.

Cattle should be treated as recommended for sheep.

Consideration may be given to the use of canvas boots for sheep and cattle.

HATCH YOUR CHICKENS AT THE RIGHT TIME.

G. D. SHAW,
Poultry Adviser.

An important factor in profit earning is that of hatching the young pullets at the proper period. It is written in every possible poultry journal that chickens should be hatched so that they begin to lay when eggs are at their highest prices, but still we have chickens hatched from March to November! No stretch of imagination will envisage a pullet hatched in March beginning to lay when prices are highest, and the same applies to those hatched in November, but between these two extremes there must be some period when the pullets can be hatched to lay when prices start to rise and then continue laying for the 12 months following.

In the years before 1929 egg prices were distinctly on the rise in the middle of February, and although the intervening years have seen a later date for this rise, prices can be expected to revert to normal at any time. Even allowing for a slight spread of price levels, we have also the most successful hatching period to consider, and that period is naturally in the spring, which is Nature's time for reproducing its species. Any departure from spring hatching is obviously unnatural.

In Western Australia the spring hatching for successful rearing is from 20th July to the 31st August for heavy breeds, and from 1st August to the first week in September for light breeds—a period of approximately five weeks for each class of breed.

Any breeding activity outside those periods must tend to decrease profits and it will be agreed that the poultry industry must endeavour to obtain the greatest profit from the stock held, and that profit must be obtained in the shortest time possible. The business man never stocks winter goods to be held over a summer period: he stocks for the season of *quickest* returns. The aim of a good business man is to produce at the cheapest cost and sell in the dearest market. This should be the aim of the poultry industry.

Rear at the cheapest period in order to be able to sell in the dearest market. The two interlock. One cannot be called tedious if this point is stressed, but in stressing this aspect of poultry farming a new method of explanation is being propounded. Let us picture the activities of the average poultry farmer during the hatching period at present used in Western Australia, from June to October, and alas, sometimes into November. He is aiming to produce 400 laying White Leghorn pullets and he has sufficient incubators to produce this number when hatching from June to October.

The machines are set as follows:—

1. June 10th, hatching on July 1st.
2. July 2nd, hatching on July 23rd.
3. July 23rd, hatching on August 13th.
4. August 14th, hatching on September 4th.
5. September 5th, hatching on September 26th.
6. September 27th, hatching on October 17th.

In each setting he averages 120 pullet chicks, a total of 720 pullets during a period of 4½ months *hatching,* and they commence to lay as follows.—

Pullets hatched July 1st, commence to lay in January and moult in April-June.
Pullets hatched July 23rd, commence to lay in January, some (say 50) moult in April-June.

Pullets hatched August 13th, commence to lay in February and continue.
Pullets hatched September 4th, commence to lay in March and continue.
Pullets hatched September 27th, commence to lay in April, but only about half are laying.
Pullets hatched October 17th, should commence in May, but generally they are not in production until the fall in prices in June.

Taking account of deaths and culling, let us assume that 80 pullets have been reared from each batch. Now what happens? The first two hatchings, which have started to lay in January, will surely go into a neck moult or even a full moult when April or May comes round. In very few rare occasions do they continue to lay through the period April to June when eggs are dear. The next two hatchings, which start to lay in late February and March, will continue to lay right through the moulting period. The last two hatchings, born in late September and October, will not begin to lay by the time prices are high, and some are not even ready to lay when prices begin to decline, so we have—

Born July—80 moulting when eggs are dear.
Born late July—40 laying, 40 moulting when eggs are dear.
Born August-September—160 laying.
Born late September—40 laying, 40 not laying.
Born October—80 not laying.

The pullets are really divided into two classes when eggs are dear—240 laying and 240 not laying, being either moulting or too young. It must be remembered that the farmer still has his old hens which are moulting, and if he is a culler he will have 240 of these birds which are a drag on the profits of the pullets.

The farm now comprises:—

240 pullets laying.	240 pullets not laying.
	240 hens in moult.
240 laying.	480 not laying.

Is it reasonable to expect 240 laying pullets to keep 480 non-layers for these three or four months? Yet such is what the industry expects.

Take farm 5, page 266, *Journal of Agriculture*, September 1937, with 550 pullets culled out to 370, all born in the one week and all laying when eggs were dear. Those 370 pullets laying 17 dozen marketable eggs per day at 1s. 7d. per dozen, average, over the 3½ months could keep 240 moulting hens and return £4 as well. But if only 185 of those pullets are laying with 185 pullets not laying, together with 240 hens moulting, things take on another aspect; 185 pullets would have to provide feed for not only the farmer and his family but also for 185 pullets not laying and 240 hens in moult—425 not laying. On the same basis of production as these 370 pullets, 185 pullets laying 8½ dozen eggs daily at 1s. 7d. average could not carry the burden. They would not even be able to feed the flock and the farmer would then run into debt. By transferring the 185 loafing pullets into the laying class by hatching them at the right time, the proportions are entirely altered to 370 laying and 240 loafing. Then it does pay. How do we accomplish that change over?

This is done by reducing the period of hatching so that it will be confined to the two most seasonable months, those confined between the last week in July to 31st August for heavy breeds and 1st August to the first week in September for light breeds.

It will be realised that by shortening the season only two hatches at three weeks' interval can be obtained, but one can hatch greater numbers by augmenting the incubator's capacity.

What if the expense is another £20 for machines The farmer will not need any more kerosene, feed or eggs in order to do the work; the only expense is for

extra incubators, sufficient in number to hatch the total quantities referred to on page 12 in half the period. He will then have the whole of the 370 pullets laying when eggs are dear and only 240 hens moulting.

Let us now strike a balance with the extra £20 spent on new machines: with this advantage he will have another 185 birds laying 8½ dozen eggs a day at 1s. 7d. average, which is 13s. 6d. a day extra coming in; it will only take 30 days to recoup the £20 extra expenditure for incubators and for the next 2½ months an extra 13s. 6d. a day is a profit which can be used with satisfaction on the farm. The machines will then have been paid for and are ready for next year.

But if he will not spend that £20 more or less, he will be depriving himself of 13s. 6d. per day extra for 75 days—too great a loss to be tolerated by any thinking person. Our farmer will have all the breeders he requires for the 240 moulting hens, the balance of a well-culled flock, which have laid profitably right up to March 31 when he then decided to make them recondition. Of course all will not be fit for the breeding pen but there will be plenty of proved producers, and as the eggs are not wanted until July, and the moulting hens will have reconditioned, nearly all will be laying by then.

If he is a purchaser of chicks—one who does not desire to hatch his own—the problem is easy. He orders his chicks to be delivered during those few weeks. He orders early and pays a deposit in order to close the contract.

If one hatchery cannot supply at the date required he must go elsewhere. He must not let the hatchery dictate what dates he will be supplied.

It should be understood that the industry must go ahead. It cannot stand still, so the conditions of to-day are going to change. The hatchery must be prepared to respond to the demand of the purchaser. This will mean that hatcheries will have a shorter season with more machines. Their remedy is obvious. The industry cannot continue to keep 425 loafers on 185 layers and the transfer must be made before contentment arrives. The new conditions are going to demand that all sections of the industry respond or go out.

The old practice was to hatch sufficient young stock to replenish the outgoing due to the two-year old hens and the farmer had only sufficient pullets on the block to recoup for the outgoing in the moulting season in April to June. It was no uncommon sight to see the farm stocked with three-quarters of the birds not laying. Such a percentage of non-layers was a severe drawback and the farmer could not pay for his feed bill let alone have anything over for himself. His debits mounted up for the whole of the moulting period and he relied on the spring lay to recoup him for that debit. Needless to say, he was not very contented with the conditions of the industry.

The whole trouble has been that the farmer was not sufficiently alive to the culling of the unprofitable birds. He never gave a thought to the loss incurred when a bird ceased to produce sufficient eggs to not only pay for feed but also to return a little over for the farmer.

Culling is the basis of all the arguments for replenishing the young stock. If one does not cull there will be at least 80 per cent. of the pullets alive at the end of the first year, so the replenishment is not so big in proportion to the situation when the remainder is only 50 per cent. of the beginning of the year.

In the *Journal of Agriculture* for September, 1937, pages 265-278 appeared an article on "Culling the Flock." The economic factors are definite and the methods can be applied with confidence by any poultry farmer.

The article was for the beginner—the farmer with little experience. It placed before him a simplified method of detecting the "duds."

It has many times been suggested that culling must be performed in daylight. This is absurd—the night is equally satisfactory.

We have been told that the birds should not be disturbed at night, yet one cannot but suggest that night culling is not disturbing to any flock.

The night work is easy to both man and bird as the birds are not rushed over a shed, they are not driven into catching crates, and they are not handled at the period of greatest activity—daylight.

The farmer should always visit the fowl sheds after dinner. The practice is extremely valuable. The inspection which takes place then is thorough. The birds are used to handling for condition. Vermin are detected (they are never seen in daylight) and sickness, if present, is easily noticed. *What is easier than to lift off the perches those duds which show up prominently when scattered throughout a flock of good birds?* All birds being settled it is easier to detect the "dud." There is no fast movement of heads and legs. The "dud" only is handled; the remainder are not touched.

In fact, all birds enjoy handling after they are trained (which training should take place early in life). Have we not heard the contented happy talking of the properly handled bird?

Are the birds trained for showing any the worse because they are tame?

Handling at night is a pleasure for all and the birds like it.

These foregoing remarks are impressive—the farmer will find his culling a pleasure and a profit. It does not interfere with his daytime duties and it does not entail hard and trying work in driving and catching.

As only a few duds are detected at a time, culling is continuous and the profits at a maximum.

Now let us take the situation of an unculled flock in April with 800 birds going through the moult and only 1,000 pullets. If 500 of these pullets are hatched in the periods which will not guarantee their laying in April, if those 500 are also moulting or have not started to lay, we are going to have a flock of 1,300 loafers, with 500 hard workers trying to keep them in food, and the farmer can wait for his share, and he will have to wait a long time. Even if one does not cull an entirely different picture will be shown if the farmer has hatched those 1,000 all to lay at the correct time, *i.e.*, when eggs are high in price. One thousand pullets producing 400 eggs a day at 1s. 7d. doz. would be able to feed the moulters and give something over for the farmer. But if the farmer was a believer in the practice of culling the moment the bird ceased profitable production, the ratio would be in the vicinity of 800 pullets producing 400 eggs a day (the 1,000 pullets would have at least 20 per cent. taken out as not profitable birds), and only 500 odd old hens going through the moult.

The position is quite clear. First we must start to cull from the moment the chick is born and continue throughout the year. We must never let up on the practice. Our birds must never be allowed to stay on the block one day after we have noticed their poor laying, and we will then appreciate the other side of the picture. We must always estimate and endeavour to rear such that we will always have twice as many pullets coming into the lay the moment the hens are beginning to moult. To do this we must reduce the hatching season to a very short one. We do not want to be keeping not only the hens when in moult but also the pullets which are as yet not near the lay. The load is too heavy.

Some will hesitate to try the short breeding season, but they can be assured that the advantages are numerous.

Let us look at the idea from another angle. The nominal cost of rearing pullets to the laying stage, taking account of the cost of eggs, kerosene for incubat-

ing and brooding, feed—in fact every cost which can be legitimately charged against the pullet to laying stage—is in the vicinity of £25 per hundred of the good, well-culled pullets left. *This £25 is a debit against the pullets, and not against the old hens.* The pullets incur the debt, therefore they must pay that debt back. Their costs should not be a charge against the laying stock. The laying stock did not want them. If they all start laying between February and March, they will begin to recoup the debt with eggs at 1s. 7d. per dozen average, and in no time they will be debt free—about the end of June or middle of July. (Last year the flocks mentioned by me above had the debt recouped by the end of June, 1937.)

But if the flock of pullets do not start to lay until the prices decline, they are going to take longer to pay off the debt. It will take twice as long when egg prices have fallen to 10d. per dozen. You will now appreciate that the spread of the lay from January (when eggs are 1s. 3d.) to July (when eggs are 1s.) causes the debt to last longer and your profit is further off. When you have recouped yourself for the expenditure on the chickens, you will then begin to make a profit, and not before. So shorten the period of debt as much as possible by hatching the chickens out so that they will all begin to lay at the rise of prices. Do not spread the hatching and so miss the maximum profit.

Buyers of chicks may be perturbed because this practice of short hatching will have a tendency to cause the hatcher to place small eggs in the incubators, but one can be assured that the hatchery is not going to ruin a trade when it is dealing with the farmer who is aware of the economic side of culling and the profits attached to the proper breeding season. The clientele which demands the best chicks at the best time will always see that they obtain what is desired, and any hatchery which falls down on the order will be well condemned by the farmers. If the hatchery works on the best lines by culling, etc., it will always be in a position to supply chicks from well tried birds (those which have stood the test of time).

What of the hatchery? The manager will most likely be faced with the problem of completing his orders in half the time taken previously. The farmer will demand the chicks between mid July and early September and if the hatchery cannot supply will go elsewhere. This will force the hatchery to expand to keep his business, and the incubator capacity will have to be doubled, the machines will be idle for a longer period each year, the depreciation will be greater and the interest will still mount up, but the hatchery must meet these mounting costs. The costs will no doubt be recouped in other directions, but the farmer who is alive to the necessity of obtaining his stock at the correct time will cheerfully assist in the matter. Prices should be so arranged that there is no hardship on any section of the industry. If the hatchery cannot carry on owing to the mounting costs—the result of the increase in the number of machines required—the industry will suffer. Therefore there must be co-operation between the buyer and the seller of chicks. The seller must guarantee his wares and then the buyer will not cavil much about a slight increase in the price of day old pullets.

Any tendency towards cut-throat prices for day old chicks will be disastrous to both sections. The buyer of day olds must demand the best at the right time and then be prepared to recoup the seller for the extra expense entailed in producing the better class of stock.

When all is said and done what is a few pounds extra per thousand as a cost for guaranteed pullets, guaranteed both as to breeding, egg size, stamina, and as to the correct time of delivery.

Apart from the economic advantages of quick hatching there are others which although not directly connected with the £ s. d. of poultry farming, must have a very direct bearing in the long run.

First of all we will be breeding from hens, birds which have successfully progressed through a moult after having proved their laying capabilities over a year of profitable production. As there will not be any need for early eggs there will then be no need to have pullets in the breeding pens.

Secondly, we will not be "tired of looking after chicks." What a drag it is to have chickens on your hands from June to December. No wonder the late hatched never seem to thrive, and we always blame the lack of something the earlier ones obtained from the soil or season. That something might be inattention on the part of the attendant, because of his or her being "tired of the sight of them," and a very good logical reason it is when late hatched do no good.

Having referred to the economic advantages of hatching at the right time in order to catch the rising prices of eggs in the autumn, the matter of autumn-hatched chicks may well be discussed also.

If for any reason the spring hatch has been insufficient to meet the requirements of the farmer, it has been a practice in the past to increase the flocks by hatching several hundreds of chicks in the autumn—March to May. Many arguments are put forward as to the advantages of the practice, but as the basis of all the discussions in business ventures is costs and profits, the sooner the industry begins to think along these lines the better. Forget for the time being about the numbers to be stocked, and also forget about replenishments.

It has been mentioned previously that the newly hatched chicken, the moment it is born, has a debt against it. The hatching costs, which costs include the feeding of both the males and females of the breeding pens, and also the wasteage entailed because of the selection of those breeds, are an initial cost which is in most cases assumed, but to the initial cost we must also add the costs of brooding and weaning, such as fuel and other incidentals, and we also have the cost of feeding to the laying stage. These costs (based on the results of 1936/37) of raising one hundred good pullets, which had been well culled, were in the region of £25.

It can be seen, therefore, that if there are 400 good pullets left at six months, the costs are in the vicinity of £100, or 4s. per bird, and *such costs are a debit on the pullets only and not on the old hens.* In simpler language, those pullets have borrowed £100 from somewhere in order to pay for their rearing, and before they can be considered as returning a profit that cost or debit must be paid back—every penny of it, and the only means of payment is through the eggs laid, plus any sum received for the sale of further culling.

The cost of feeding a pullet for the year 1936/37 was 11s. per year, or in round figures, we can work on 2½d. per week. A finer figure does not matter when explaining the point under discussion (profit over debits). Using the average figures (net) received for all grades of eggs January to June, 1937, the average price received was 1s. 7d. per dozen, and using the conservative figure of 50 per cent. production or even three eggs per week, the return of the August and early September hatched bird will be ¼ dozen @ 1s. 7d. = 5d.; cost of feed, 2½d.; profit over feed, 2½d. Therefore, the bird will be paying off her debt at 2½d. per week, and as she has 4s. to wipe out, it will take her 20 weeks in order to recoup the farmer for the money he has already paid out on her upbringing.

Now let us take the pullet which is born in the autumn, say March or April or May, laying in the normal six months (starting to lay in August, September or October) we can assume she lays the same class and grade of eggs as her August or early September-hatched sister. She will lay at about the same rate, but for better illustrations let us give her an average of four eggs per week against the three eggs credited to her spring sisters.

The prices of all eggs during the months of spring, 1936, were as follows:—

	s.	d.
In September average price all grades was	0	10¾
In October ,, ,, ,, ...	1	0
In November ,, ,, ,, ...	0	11
In December ,, ,, ,, ...	0	11
In January ,, ,, ,, ...	1	1¼
In February ,, ,, ,, ...	1	1¼
In March ,, ,, ,, ...	1	2

On these prices the pullets will take more than three times as long in which to clear accounts, and at the period when they should be returning a profit there will surely be a general moult.

The following is a balance of costs and credits for pullets born in March and laying in September:—

	s.	d.			s.	d.
Sept.—Cost to maturity	4	0		Db. balance	4	0
Eggs laid Sept., 16 @ 10¾ ..	1	2½				
Feed cost, 4 weeks @ 2½d. ..	0	10½	profit Sept., 4½d.	debit	3	7½
Eggs laid Oct., 16 @ 1/-	1	4				
Feed costs, 4½ weeks at 2½d. ..	0	11½	profit Oct., 4½d.	debit	3	3
Eggs laid Nov., 16 @ 11d. ..	1	3				
Feed costs, 4½ weeks at 2½d. ..	0	11½	profit Nov., 3½d.	debit	2	11½
Eggs laid Dec., 16 @ 11d. ..	1	3				
Feed costs, 4½ weeks at 2½d. ..	0	11½	profit Dec., 3½d.	debit	2	8
Eggs laid Jan., 16 @ 1/1¼ ..	1	6				
Feed costs, 4½ weeks at 2½d. ..	0	11½	profit Jan., 6½d.	debit	2	1½
Eggs laid Feb., 16 @ 1/1¼ ..	1	6				
Feed costs, 4 weeks at 2½d. ..	0	10	profit Feb., 8d.	debit	1	5½
Eggs laid March, 16 @ 1/2 ..	1	7				
Feed costs, 4½ weeks at 2½d. ..	0	11½	profit Mar., 7½d.	debit	0	10
Eggs laid April, 16 @ 1/8 ..	2	3				
Feed costs, 4 weeks at 2½d. ..	0	10	profit Apr., 1/5	credit now	0	7

If the birds do not now go into the moult, they have been over seven months in the lay before they have returned a profit to the owner, but it is generally recognised that the autumn-hatched pullet will, in nine cases out of ten, go into the moult. Imagine the position when the flock does start to moult. We can assume the moult will be starting in February and continue to the end of June. Such being the case, we find that the pullets are just beginning to balance the ledger when they are moulting, and for the next three or four months will be again creating a further debit—that of the feed costs over those months of rest.

Therefore the autumn-hatched pullet is in the class which is a handicap until it has completed the moult.

Put another way: the spring-hatched pullets have liquidated their debt by the end of June or the middle of July, at which time they are 9 to 10 months old, and are returning a profit to the owner from July or August until they are marketed, whereas the autumn hatch have not liquidated their debt until near the end of April (that is, if they do not go into a moult in the meantime). It is safe to say that the autumn hatching of pullets is not a paying proposition under these conditions, and should never be practised when egg-production is the mainstay of the farmer's activities.

In comparing the spring-hatched pullet against the autumn-hatched, we can do it another way. The normal age of maturity being six months with the spring-hatched pullet, we have six months for growing and then 12 to 13 months of laying, of which three to four months' lay is required to recoup the debit. We then have the balance of nine months' profitable lay before the pullet is 18 months old, and then the three months' moult.

But with the autumn-hatched pullet we still have six months' growing, with six months' lay, none of which shows a profit, and then we have the three months' moult.

In July both classes lay again, and continue for the following nine months. The comparison is then as follows:—

Born Sept. 1. 6 months growing.	Born March 1 next autumn.
3 months laying to recoup. 9 months profitable laying.	6 months growing. 6 months laying to recoup.
3 months moult.	3 months moult.
3 months to recoup cost of feed during moult. 6 months profitable laying.	3 months to recoup cost of feed during moult. 6 months profitable laying.
30 months.	24 months.

This shows that in the September-hatched pullet we have 15 months' profitable lay during a life of 30 months, or to the second moult, but the autumn-hatched pullet gives us only six months' profitable lay in a life of 24 months, or to the second moult.

We have had no advantage by augmenting our spring-hatched chickens with autumn hatches. It would have been more profitable to have done without the autumn-hatched and concentrated for greater numbers during the following spring season.

To hark back a little: It must be agreed that the sooner the pullet pays off the debt of rearing the sooner the farmer will be able to reap the profits from his flock; therefore, care must be taken to see the hatching is completed in the correct period. It must also be realised that the price factor has a marked bearing on the subject. If the egg prices begin to rise to fairly high levels during the January and February of the year, the pullets will be able to recoup the debt sooner, and it also allows of a slightly longer hatching period, inasmuch as the hatching can be started a little sooner than would be practicable if prices were very low during those months, making sure we do not start too early—we must beware of the early pullets and their going into a moult. Of course, were the prices to rise early in the summer—in December for instance—the sooner the autumn-hatched pullet would liquidate its debt.

The matter of profit should be in front of the poultry farmer at all times, and a keen analysis of all factors will be the only way he will be able to solve what is now a very controversial subject. But we must not forget the principle that *all chicks create a debit,* and before they can return a profit to the farmer *the debit must be wiped out.*

ERRATA.

Journal of Agriculture, March, 1937, p. 19, "Royal and District Agricultural Societies' 50 acre Crop Competition, 1936": The rainfalls for Nyabing and Hyden Rock should read as follow:—

					Growing Period.									
——	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Nyabing	94	14	10	67	213	349	79	181	74	17	913	42	54	1,194
Hyden Rock	36	14	18	22	131	241	105	193	63	12	745	25	80	940

Journal of Agriculture, December, 1937, p. 382: "The Control of Toxic Paralysis (Botulism) in Sheep and Cattle." In the twenty-second line of third paragraph "5gm" should read "50gm."

FERTILISER—ADDITIONAL REGISTRATIONS.

The last December issue of this Journal contains a list of the fertilisers registered for the current fertiliser year, together with the minimum percentages of the fertilising ingredients. Additional registrations, with the respective analyses, are shown in the following table:—

Name of Fertiliser.	Reg. No.	Brand.	By Whom Registered.	Nitrogen (N) as				Phosphoric Acid (P_2O_5) as				Potash (K_2O) as		Cash Price per ton on Rails, Perth.
				Nitrate.	Ammonia.	Blood and Bone.	Bonedust.	Water Sol.	Citrate.	Acid Sol.	Total.	Sulphate.	Muriate.	
				%	%	%	%	%	%	%	%	%	%	£ s. d.
Blood and Bone	138	Cockbills ..	Harold & Murray	.		5·25	.		3·0	9·0	12·0	....	..	10 10 0
Nitrate of Soda	139	Champion ...	A. Hicks . .	16 0		..			..	...	..	...	.	*
Blood and Bone	140	B P B .. .	do . .	.	.	5 0	.		10 0	5·0	15·0	..	..	9 0 0
Do.	141	K.B.M. .	R. Bates, Kalgoorlie .			5·0			.	...	9·0	....	...	8 10 0
Bonedust	142	do.	do. do. .		..	..	3·0		...	....	18·0	....	..	6 15 0
Animal Fertiliser	143	State Abattoirs, Midland Junction	State Abattoirs, Midland Junction	.		8·0	.	.	.	5·0	5 0	....	...	10 0 0†

* Price on application. † Price at works.

THE PAPAW OR PAPAYA.

(*Carica papaya.*)

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With frequent inquiries being made as to the method of propagation and with an increasing demand for this fruit in the metropolitan markets, it is felt the following notes will be of interest.

It is not the intention of the writer to convey to Gascoyne River settlers that the time is opportune for the establishing of any large commercial areas, but there are sufficient indications to warrant the consideration by settlers of the planting of a few "trees" as a profitable sideline to banana growing. Without entailing much additional time, water or other costs, they could be grown in such positions as along the irrigation drains, on the headlands, between the outside banana rows and the wind breaks, between the young fruit trees or in the pineapple beds. Prices in the past for this fruit have been encouraging despite the fact that little or no attention has been paid by settlers as regards type, quality or condition of fruit being sent to markets. True though it is that the demand is greater than the supply, considerable caution must be taken with the amount of supply owing to the peculiar nature of this and many other tropical fruits, a liking for which is an acquired taste.

The papaw or papaya (erroneously called paw paw by many in this State and which is an entirely different type of plant indigenous to the Central U.S.A.) is a typical tropical plant and is a native of tropical America. It has proven itself quite suitable to Gascoyne conditions providing that normal care and attention are paid to cultural methods, and thrives best in a soil rich in organic matter possessing good drainage, in a sunny position free from frosts and boisterous winds.

THE PLANT.

This is a fast growing herbaceous plant possessing usually an erect trunk attaining a height of 10 to 25 feet, which is fleshy and hollow. The leaves, which are large, sometimes 2 feet across, are dark green and are produced in clusters at the top of the plant on hollow, smooth stiff stalks. This growth is erect in the early stages of development but later as the leaf stalks grow, they bend outwards and then downwards, giving the plant a palm-like effect. The life of a leaf varies from 4-6 months and at the axils or union of the leaf stalk and trunk the flowers are produced.

THE FLOWERS—MALE AND FEMALE.

The papaw is normally dioecious, *i.e.*, with the staminate or male and pistillate or female flowers produced on different plants. In addition to the staminate and pistillate forms, intermediate forms have been observed in which flowers of each sex occur in one plant. Staminate flowers may occur with rudimentary stigmas and ovaries which give rise to small worthless fruit and there is a hermaphrodite or bi-sexual type which regularly produces perfect flowers, is self-pollinated and yields excellent fruit. (While fruit of the staminate tree have been described as worthless there are instances of large and good-flavoured fruit having been produced but possessing thin skin and soft flesh which make them unfit for transport to market.) In the dioecious type the staminate or male plant (Figs. 1 and 2) the flowers are white, about an inch long and are born in clusters on long pendant

racemes sometimes 5 or 6 feet long, while the pistillate or female plant produces creamy yellow flowers about 2 inches long close to the trunk of the plant on short thick stalks from half an inch to 2 inches in length (Figs. 3 and 4). Both types of flowers emit a very pleasant scent.

It appears that nature holds the determining of the papaw sex as a close secret for although many and varied are the suggestions that have been expounded concerning the determination of sex in the early stages of growth of the plant, the

Fig. 1.—Staminate flowers on the papaw plant.

writer has yet to be convinced that any of the so-called "positive tests" are reliable except that the more vigorous plants in the nursery may possess a greater percentage of female plants. This line of selection is desirable apart from the viewpoint of sex, in that the most vigorous plants are the quickest to flower, thus maturing an early crop and such crop is usually born low on the plant which facilitates harvesting.

THE FRUIT.

The shape of the fruit varies from oblong to round, depending not only on type or variety. Soil, season, climate and cultural conditions seem to have considerable bearing on shape. The fruit when first developed are creamy white, but quickly take on a dark green colour. The weight varies from 1-10 lbs. when mature. When ripe the skin is smooth, thin and usually of a yellow to deep orange colour, while

Fig. 2.—Flowering habit of the male tree.

some types are pale green and are not considered very favourably by the trade. The flesh is of firm butter texture and possesses a yellow to orange-yellow colour. In the centre of the fruit is a fairly large cavity where are carried numerous round or oblong-shaped black seeds. The thickness of the meat or flesh varies from half an inch to two inches.

METHODS OF PROPAGATION.

The papaw may be propagated from cuttings, by grafts or seed, the latter being the commonest and to date most satisfactory method.

Cuttings are most successfully rooted when small limbs are removed from plants and care is taken to see that the natural swollen growth at the union of the small limb and parent plant is attached to the cutting.

Although this plant can be grafted successfully, there is little to be gained from this method of propagation for it has been observed that the parental qualities are not always retained except that the age of the parent seems to be transmitted in the scion. These facts appear to be present to the same degree in rooted cuttings.

SELECTION.

As already mentioned the propagation by seed is the best method. Little attention has been paid in the past on the Gascoyne in the matter of selection, with the result that many worthless strains are in evidence which are not only unremunerative but are a menace to the better types growing in the same vicinity.

Seed should be selected from a fully ripe fruit and from a tree known to be of a healthy, robust, heavy bearing nature. The fruit should possess a thick leathery highly coloured skin, a flesh of firm texture and good thickness. The shape, if possible, should be oblong, as this appears to be favoured by the trade, and a medium sized fruit is the most popular. Fruit with a very prominent nipple at the calyx end should be avoided as this tends to ripen earlier than the main body of the fruit and is subject to bruising, thus detracting from its value when presented to the buyer.

THE SEED BED.

Seed may be raised either in beds or boxes which contain a good rich sandy loam. The seed should be planted soon after being removed from the ripe fruit but seed will retain a high percentage of germination for twelve months if washed after removal from the fruit and kept in an airtight jar in a cool place. The best time for raising seedlings is during the spring months—September-December. The seed should be planted in rows about 12 inches apart with 2-3 inches between seeds and covered with about half an inch of soil. The seedlings should be above ground in 2-3 weeks after planting in the spring. Thinning the seedlings out to 6-8 inches will encourage good sturdy growth. The soil should be kept only moist as excessive watering may cause damping off. If the seed beds are in sunny positions the seedlings should be ready for removal to their permanent positions in two months from planting of seed when the seedlings should be 6-8 inches high (Fig. 6).

PLANTING OUT.

Several hours prior to transplanting, the seed beds or boxes should receive a liberal watering, and planting out should be done in the cool of the day. After selecting the most robust and vigorous plants, every care should be taken to avoid destroying the roots or the drying out of roots during transplanting. A thorough watering is advisable as soon after planting as possible, and once the plants show signs of being established, weekly irrigations should be sufficient. If planting out large seedlings, it is advisable to remove the majority of the leaves several days prior to planting, leaving portion of the petiole or leaf stalk attached to the plant.

Owing to the impossibility of determining the sex of the seedlings prior to flowering, it is advisable to adopt close planting and planting in pairs about 18-24 inches apart, allowing 3-4 feet between pairs, is suggested (Fig. 7). The thinning out of males, which usually predominate, should be done as soon as detected, and they should be cut up and dug into the soil as they are a valuable manure for the

remaining plants. No definite advice can be given as to how many males should be left as position of the plants has a considerable bearing on the matter, but as a guide 3 or 4 robust males should be satisfactory if well dispersed amongst 20 to 30 females.

While most plants have the tendency to develop the one upright stem, there are some that will develop lateral limbs early in life, which is very desirable as the plant then tends towards a low type growth carrying a larger crop of medium sized

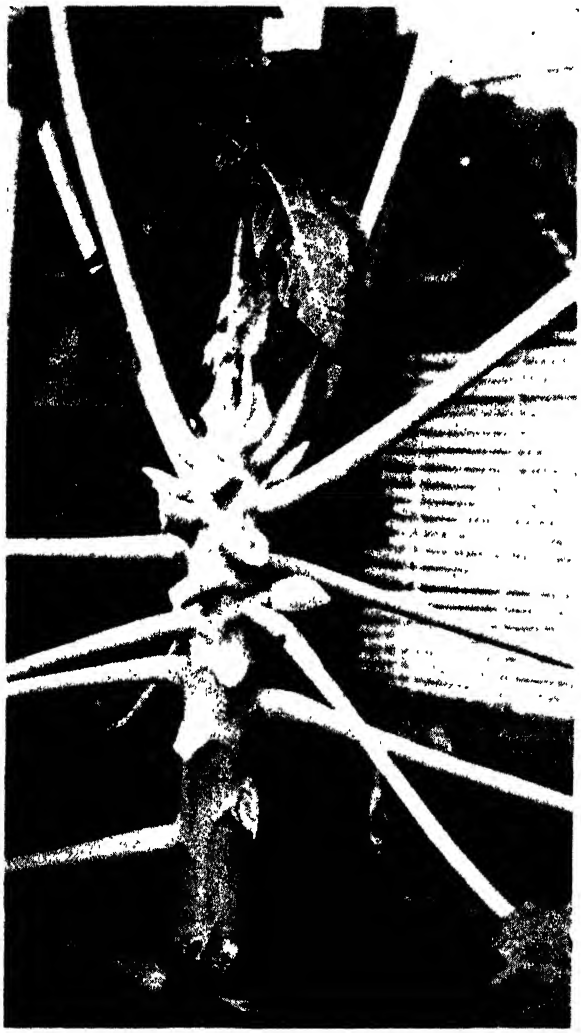

Fig. 3.—Flowering and fruiting habit of female tree.

fruit low to the ground. To encourage the branching type habit, the terminal growth may be nipped out when the plant is 3-5 feet high, but even this does not always force out the side vegetation. Some growers wait until the first main crop has set before removing the terminal growth when the branching habit can usually be obtained.

While plants may live for 10 or more years, it is usually found that after the second or third year the plant has produced its best commercial crops.

The plant readily responds to soil cultivation and liberal supplies of well-rotted organic matter, and will benefit from an application of Wyndham meat works manure whenever manuring the bananas, bearing in mind that if the plant is kept producing vegetative growth, there will be a constant cropping of fruit.

Fig. 4.—Eight months old pistillate or female flowering papaw tree.

HARVESTING AND HANDLING.

Like most fruits the papaw attains its best flavour if allowed to remain on the plant until ripe, but this is not practicable if fruit is to arrive at Perth markets in good condition. The stage to harvest for metropolitan markets will vary with the season. During the winter months it is possible to allow the fruit to remain on the trees until a fair amount of colour is showing, but in the summer it is necessary to harvest as soon as the yellow colour commences to show on the fruit.

Harvesting should be done during the cool of the day by holding the fruit firmly and giving it a slight twist, when it should come away with portion of the fruit stalk attached. The fruit should be handled with the greatest of care as it is very easily bruised and marked; even the slightest marking at harvesting becomes very pronounced when the fruit is ripe. If possible, the fruit should be allowed to sweat in a cool place for about 12 hours prior to packing. The fruit may be packed in the standard tropical fruit case (24¾ inches by 12 inches by 12 inches, inside

Fig. 5.—Bearing habit of male tree.

measurement), or during times of high prices the ¾ flat is more desirable. A layer of wood wool, dry straw or crumpled paper should be placed in the bottom of the case, and each fruit should be liberally wrapped in paper before being placed in the case, making sure that a padding of the paper covers the stem end of the fruit. The fruit may be packed either erect or lengthwise along the case. Never place the fruit across the case, for after lidding the case always travels on its side and fruit so packed are liable to receive damage to the stem or calyx ends. When packed the fruit should be slightly higher than the side of the case, and a liberal layer of wood

wool or crumpled paper should be placed over the fruit before lidding. The use of dead banana leaves as padding material is not to be encouraged for it not only detracts from the "get up" of the product but produces an unpleasant musty odour to the packed article. Use even grade fruit as far as possible, and upon the end of the case mention the count or number of fruit in the case.

USING THE FRUIT.

The most popular method of using the fruit is by cutting it in halves or slices lengthwise, removing the seed and to suit the taste, sprinkling sugar, salt, pepper, orange or lemon juice over it. Served in this manner it is a very popular breakfast dish. Some people prefer a few of the seeds to be served with the fruit as they have a flavour similar to water cress and are claimed to possess great digestive properties. This fruit is becoming increasingly popular in cafes when served with ice cream. Cut in halves with the seed removed, and port wine added, it makes a delicious sweet for the menu.

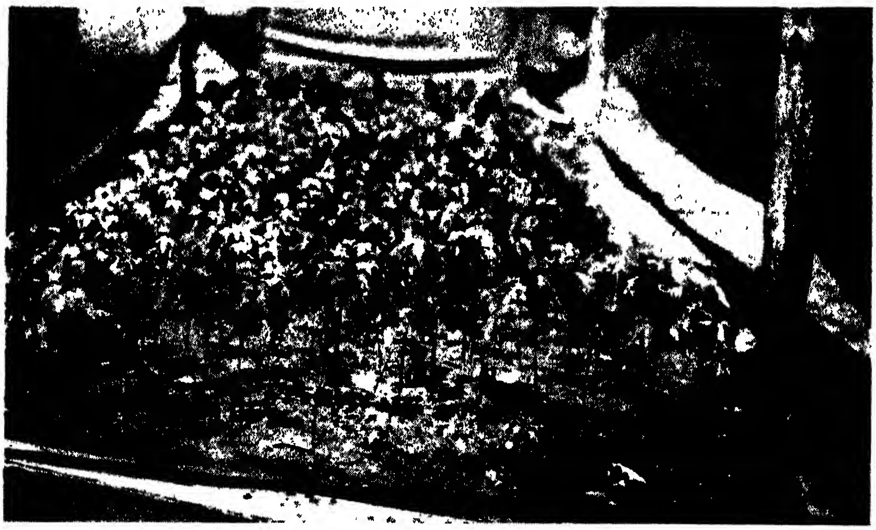

Fig. 6.—Papaw seedlings in the seed bed and at a suitable stage for transplanting.

Great medicinal properties are claimed for the fruit and plant from which is procured a milk-like fluid which when dried to a white powder contains "papain" and is used in the manufacturing of special digestive foods and chewing gum. The papain is harvested by making slight incisions in the skin of the fruit and the exuding fluid is collected in small vessels and then dried and ground to a powder. One authority claims that to extract 1½ lbs. of papain approximately 1,500 average size fruit are required to be treated.

PESTS AND DISEASES.

The plant is comparatively free from pests and diseases in Western Australia. Slight infestations of Red Spider have been recorded. The major loss of fruit appears to be from sun scald and slight fungus attack in the form of a rot which develops at the calyx end and exposed side of the fruit. The orange-piercing moth also does slight damage during drought periods.

REASONS FOR CROP FAILURES.

Crop failure, or fruit developing towards maturity and then falling from the plant, may be the result of blossoms being attacked by insects or disease, or unfavourable soil or climatic conditions at fruit setting stage. Excessive watering or manuring at this stage can also cause trouble, but where these conditions do not prevail it is quite possible that pollination is at fault. The shrivelling and dropping of fruit from the male tree is common, and if an inspection is made of the interior of the fruit, it will be found that the seed is undeveloped. Infertile fruit is usually insipid in flavour and the flesh is thin and leathery.

Fig. 7.—Young papaw block. Note spacing of plants.

THE COST OF FEEDING PURE BRED COWS UNDER THE AUSTRALIAN OFFICIAL HERD RECORDING SCHEME, WESTERN AUSTRALIA, 1936-7.

By OFFICERS OF DAIRY BRANCH.

In this article the cost of feeding pure bred cows during the period July 1st, 1936, to June 30th, 1937, has been computed on a similar basis to that adopted during the past five years, and the comparative value of the 25 herds assessed as producers of butter fat and milk.

Table 1 sets out the prices used in arriving at these costs, but, whilst each price is believed to be a fair average throughout the year, in individual cases a variation may occur, particularly in the case of home grown fodders. In general, values of the main concentrates are higher this year than last, but are offset by the fact that more farmers are realising the value of home grown crops and conserved fodder.

TABLE I.

PRICES USED IN VALUATING THE FOODSTUFFS CONSUMED DURING THE YEAR ENDED 30TH JUNE, 1937.

	£	s.	d.
Chaff, per ton	5	6	9
Wheat (crushed), per bushel	0	3	6
Oats (crushed), per bushel	0	2	7
Bran, per bushel	0	1	6
Pollard, per bushel	0	1	6
Silage, per ton	0	10	0
Meggitt's Meal, per ton	14	0	0
Proteena, per ton	12	0	0
Cowmeal, per ton	11	12	0
Keymeal, per ton	12	0	0
Brewer's Grains, per bushel	0	0	6
Green Lucerne, per ton	1	0	0
Green Maize, Sudan Grass, and Cereal Crops—			
Chaffed, per ton	0	15	0
Grazed, per head per week	0	2	6
Meadow Hay, per ton	3	0	0
Pasture, per head per week—			
Good, green	0	2	6
Dry	0	1	6

Table 2 shows the average results over the past 14 years.

TABLE II.

PURE-BRED COWS UNDER OFFICIAL TEST—AVERAGE RESULTS OVER A PERIOD OF 14 YEARS.

Year ended 30th June.	Average Milk Yield per Cow.	Average Butter Fat per Cow.	Average Cost of Feed per Cow.	Average Cost of Feed to Produce 1lb. Butter Fat.	Average Cost of Feed to Produce 1 gallon Milk.	Average Price, Butter Fat per lb.
	galls.	lbs.	£ s. d.	pence.	pence.	pence.
1924	600	319.50	10 4 10	7.70	4.09	19.5
1925	652	308.59	14 13 2	10.77	6.15	17.5
1926	624	312.01	14 14 7	11.15	5.66	19.0
1927	602	290.72	14 10 5	12.00	5.79	19.0
1928	592	280.56	15 11 4	13.34	6.34	19.5
1929	629	295.10	15 1 0	12.24	5.74	20.0
1930	636	294.98	14 10 3	12.74	5.10	19.5
1931	643	301.60	9 14 7	7.74	3.64	16.0
1932	696	318.96	10 18 3	8.21	3.76	14.0
1933	664	308.60	9 2 3	7.08	3.29	11.0
1934	720	333.70	10 2 6	7.28	3.37	10.0
1935	682	326.61	9 18 0	7.34	3.49	12.5
1936	681	320.14	8 14 7	6.54	3.08	12.5
1937	685	309.31	11 5 1	8.73	3.94	14.5

The low production costs shown by the Jersey herds in Table 3 are due mainly to the fact that nearly all these herds are in the wetter portions of the State, and, with one exception, are producers of butter fat only. This means that the cows come into profit in April or May, thus having the benefit of the longest possible period on natural green feed.

Amongst the Guernsey and Australian Illawarra Shorthorn herds, however, are several whole milk producers, and, as it is necessary for their owners to maintain a regular supply of market milk throughout the year, they sacrifice portion of their efficiency in being unable to bring in all their cows during the autumn.

TABLE III.

BREEDS COMPARED AS PRODUCERS OF MILK AND BUTTER FAT.

Breed.	Average Yield of Milk per Cow during 9 months.	Average Test.	Average Yield of Butter Fat per Cow during 9 months.	Average Cost of Feed per Cow.	Average Cost of Feed to Produce 1 gallon Milk.	Average Cost of Feed to Produce 1lb. Butter Fat
	lb.		lb.	£ s. d.	pence.	pence.
Guernsey (5 herds) ...	6,220	5.14	319.87	11 11 6	4.47	8.68
A.I.S. (11 herds) ...	7,674	4.03	309.61	13 9 9	4.22	10.46
Jersey (9 herds) ...	5,713	5.31	303.12	6 11 9	2.77	5.25

The great influence of climatic conditions is well illustrated in Table 4, which compares herds from "Wet" and "Dry" areas. Although average production is approximately the same, the costs in the "Dry" areas are double those in the "Wet" areas, which indicates the necessity for succulent conserved fodder and pasture establishment, together with controlled grazing wherever possible.

TABLE IV.

COST IN LIGHT RAINFALL AREAS COMPARED WITH THE SOUTH-WEST.

Average.	Production.		Cost of Feed for—	
	Milk.	Butter Fat.	1 Gallon Milk.	1lb. Butter Fat.
	lb.	lb.	pence.	pence.
Dry Areas (13 herds) ...	7,149	307.17	4.71	10.97
Wet Areas (12 herds) ...	6,326	310.93	2.44	4.98

The main Table, shown below, gives a very wide range of results and is arranged in order of merit according to profitable production of butter fat. Mr. P. G. Hampshire, of Yarloop, is to be congratulated on securing first place in this table with his Guernsey herd, figures which indicate excellent judgment in feeding for maximum production.

Although these cows were well fed, home-grown maize and clover hay, together with grazing on well-managed pastures, has kept the cost of feeding well below the average.

It will be noted that Mr. Hampshire's herd did not secure the highest butter fat average, nor was his cost of production per lb. the lowest on the list, but, by feeding judiciously for maximum output, without over-feeding, his herd showed the excellent return of £16 13s. 7d. per cow.

The figures for one herd in particular, *i.e.*, Herd "B," on this list indicate that the cows were underfed, and, although the cost per lb. was extremely low, the production of butter fat was 48 lbs. lower than the average, and the available skim milk 1,400 lbs. lower.

Results which deserve special mention are those achieved by Herd "Z" owned by Mr. W. G. Burges. Although this farm receives only 18 inches of rain per annum, full advantage is taken of the wet months to conserve fodder in the form of silage. This, together with lucerne and excellent cereal grazing, formed the major portion of the cows' diet.

TABLE V.

HERDS IN ORDER OF MERIT AS PROFITABLE BUTTER-FAT PRODUCERS.

Place.	Herd.	District—W = Wet, D = Dry.	Breed.	Average Butter Fat per Cow for 9 months.	Available Skim Milk per Cow.	Value of Butter Fat at 14½d. per lb.	Value of Skim Milk at 1d. per gallon.	Gross Return from Butter Fat and Skim Milk.	Cost of Feed per Cow for 9 months.	Profit per Cow.	Cost of Feed to produce 1 lb. Butter Fat.
				lb.	lb.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	pence.
1	D	W ...	Guernsey ...	367.65	4,742	22 4 1	1 19 6	24 3 7	7 10 0	16 13 7	4.89
2	W	W ...	Jersey ...	346.22	4,217	20 18 1	1 15 3	22 13 4	6 9 3	16 4 1	4.48
3	Z	D ...	A.I.S. ...	391.68	7,032	23 13 4	2 18 7	26 11 11	11 14 11	14 17 0	7.19
4	S	W ...	Jersey ...	318.64	3,674	19 4 11	1 10 7	20 15 6	6 6 5	14 9 1	4.70
5	B	W ...	do. ...	261.43	3,015	15 16 0	1 5 2	17 1 2	2 16 7	14 4 7	2.59
6	AC	W ...	A.I.S. ...	307.89	5,453	18 11 9	2 5 5	20 17 2	6 19 3	13 17 11	5.42
7	T	W ...	do. ...	271.52	4,747	16 8 0	1 19 7	18 7 7	4 19 9	13 7 10	4.41
8	H	W ...	Jersey ...	317.69	3,126	18 3 8	1 6 1	19 9 9	6 6 1	13 3 8	4.76
9	K	W ...	do. ...	275.13	3,416	16 12 3	1 8 6	18 0 9	5 7 3	12 13 6	4.68
10	I	D ...	do. ...	332.71	3,806	20 1 11	1 11 9	21 13 8	9 0 4	12 13 4	6.50
11	U	W ...	Guernsey ...	281.04	3,221	16 19 7	1 6 10	18 6 5	5 13 8	12 12 11	4.85
12	E	W ...	Jersey ...	281.88	3,272	17 0 4	1 7 3	18 0 7	6 4 8	11 15 11	5.31
13	Y	W ...	do. ...	253.99	2,143	15 6 11	0 17 10	16 4 9	4 10 1	11 14 8	4.26
14	AA	D ...	A.I.S. ...	327.33	5,627	19 15 6	2 6 11	22 2 5	10 9 0	11 13 5	7.67
15	M	D ...	Guernsey ...	381.78	4,330	23 1 2	1 16 1	24 17 3	14 15 9	10 1 6	9.29
16	L	D ...	Jersey ...	405.54	4,262	24 10 0	1 15 6	26 5 6	16 17 4	9 8 2	9.97
17	AB	D ...	A.I.S. ...	247.01	5,460	14 18 5	2 5 6	17 3 11	8 6 11	8 17 0	8.11
18	R	W ...	Guernsey ...	288.63	3,283	17 8 9	1 7 4	18 16 1	10 7 9	8 8 4	8.63
19	V	D ...	A.I.S. ...	315.00	5,424	19 0 7	2 5 2	21 5 9	16 7 6	4 18 3	12.48
20	G	D ...	do. ...	318.42	5,384	19 4 9	2 4 10	21 9 7	16 17 9	4 11 10	12.74
21	AD	D ...	do. ...	267.71	4,202	16 3 5	1 15 0	17 18 5	14 4 5	3 14 0	12.75
22	X	D ...	do. ...	262.61	4,058	15 17 3	1 13 10	17 11 1	15 0 7	2 10 6	13.74
23	N	D ...	Guernsey ...	319.83	4,015	19 6 4	1 13 6	20 19 10	19 4 9	1 15 1	14.39
24	F	D ...	A.I.S. ...	286.74	4,295	17 6 3	1 15 10	19 2 1	18 6 1	0 16 0	15.32
25	Q	D ...	do. ...	269.28	4,718	16 5 3	1 19 4	18 4 7	21 15 9	—3 11 2	19.40
Average	...	...	... ...	309.31	4,423	18 13 9	1 16 10	20 10 7	11 5 1	9 5 6	8.73

Available Skim Milk = [Total Milk—60 gallons—10%]—120 gallons.

In computing the available skim milk, it is assumed that the calf consumes 60 gallons of whole milk, 10 per cent. of the milk goes with the cream, and a further 120 gallons of skim milk is fed to the calf.

TABLE VI.

HERDS IN ORDER OF MERIT AS PROFITABLE MILK PRODUCERS.

Place.	Herd.	Breed.	Average Milk per Cow for 9 months.	Value of Whole Milk at 1/- per gallon.	Cost of Feed per Cow for 9 months.	Profit per Cow.	Cost of Feed to produce 1 gallon Milk.
			lb.	£ s. d.	£ s. d.	£ s. d.	d.
1	Z	A.I.S. ...	9,747	48 15 0	11 14 11	37 0 1	2.89
2	AC	do. ...	7,992	39 19 0	6 19 3	32 19 9	2.09
3	AB	do. ...	8,000	40 0 0	8 6 11	31 13 1	2.50
4	T	do. ...	7,308	36 11 0	4 19 9	31 11 3	1.64
5	AA	do. ...	8,186	40 19 0	10 9 0	30 10 0	3.06
6	D	Guernsey ...	7,202	36 0 0	7 10 0	28 10 0	2.49
7	W	Jersey ...	6,619	33 2 0	6 9 3	26 12 9	2.34
8	S	do. ...	6,015	30 2 0	6 6 5	23 15 7	2.48
9	B	do. ...	5,283	26 8 0	2 16 7	23 11 5	1.29
10	V	A.I.S. ...	7,960	39 16 0	16 7 6	23 8 6	4 93
11	K	Jersey ...	5,729	28 13 0	5 7 3	23 5 9	2.25
12	G	A.I.S. ...	7,915	39 12 0	16 17 9	22 14 3	5.12
13	U	Guernsey ...	5,512	27 11 0	5 13 8	21 17 4	2.47
14	I	Jersey ...	6,162	30 16 0	9 0 4	21 15 8	3.51
15	E	do. ...	5,569	27 17 0	6 4 8	21 12 4	2.67
16	H	do. ...	5,406	27 1 0	6 6 1	20 14 11	2.80
17	M	Guernsey ...	6,745	33 15 0	14 15 9	18 19 3	5.26
18	AD	A.I.S. ...	6,602	33 0 0	14 4 5	18 15 7	5.17
19	R	Guernsey ...	5,581	27 18 0	10 7 9	17 10 3	4.47
20	X	A.I.S. ...	6,442	32 4 0	15 0 7	17 3 5	5.60
21	Y	Jersey ...	4,314	21 11 0	4 10 1	17 0 11	2.51
22	L	do. ...	6,669	33 7 0	16 17 4	16 9 8	6.07
23	F	A.I.S. ...	6,706	33 11 0	18 6 1	15 4 11	6.55
24	Q	do. ...	7,175	35 18 0	21 15 9	14 2 3	7.29
25	N	Guernsey ...	6,394	31 19 0	19 4 9	12 14 3	7.19
Average	...	... ...	6,848	34 5 0	11 5 1	22 19 11	3.94

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F.A.Q. SAMPLES OF PAST SEASONS.

By L. W. SAMUEL,
Cereal Research Officer.

The Department of Agriculture has stored samples of the f.a.q. wheat of past seasons and it was considered of interest to examine these by the Pelshenke (1930-31) or wholemeal fermentation time test (Cutler & Worzella 1931) for baking quality. This test as conducted in this laboratory consists of making the dough-ball (in triplicate) from 5g. of wheat meal (Wiley mill, 1mm. sieve) with 2.7 mls. of a suspension of 10g. of compressed yeast in 108 mls. of water and immersing the doughball in water in a cabinet maintained at 32° C. At first the doughball sinks, but soon rises to the surface because of the production of carbon dioxide gas by the yeast. This time of rise is noted as a measure of the activity of the yeast and if the time of rise is more than 15 min. the test is repeated with fresh yeast

After rising to the surface the doughball continues to expand until finally the expansion causes disintegration of the ball. The time from placing the ball in the water till the first piece breaks off is considered to be a measure of the baking quality of the wheat, the longer the time the better the quality.

Twelve samples of f.a.q. wheat were available, the oldest being the 1919-20 season's sample. These were tested on 28th October, 1937, and the results are shown in Table 1 together with the "time" obtained for the more recent samples which were tested when the f.a.q. sample was obtained. Table 1 also shows the diastatic activity of the ground wheat as determined by the method of Blish & Sandstedt (1935).

The results are shown graphically in fig. 1.

Table 1.

Analyses of f.a.q. samples.

Season.	Diastatic activity mg. maltose/10g./hr.	Pelshenke time (mins.).	
	1.	1.	2.
1919-20	152	62	..
1921-22	122	59	..
1923-24	140	75	..
1924-25	198	78	..
1925-26	140	90	..
1927-28	136	61	..
1928-29	132	63	..
1929-30	152	62	..
1930-31	136	49	..
1932-33	214	53	..
1933-34	184	49	40
1934-35	184	51	31
1935-36	..	..	38
1936-37	..	..	36

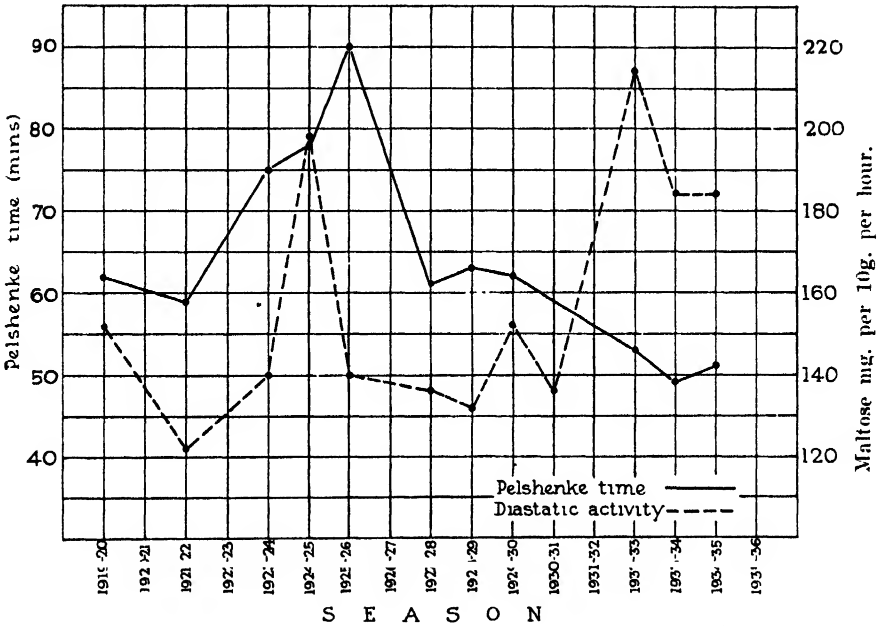
1. Tested 28th October, 1937.

2. Tested at time of fixing the f.a.q. standard.

The diastatic activity of the samples is very variable but does not appear to have any uniform trend. It is interesting to note that diastatic activity is still present in wheat stored for nearly 18 years.

The baking quality after storing as judged by the Pelshenke time is practically the same for the 1919-20 and 1921-22 seasons' samples, increases to a maximum for the 1925-26 season, decreases to practically the same value for the 1927-28 to the 1929-30 samples and then decreases to practically the same value for the 1930-31 to the 1934-35 samples.

Since there is no connection between the diastatic activity and the Pelshenke time there appears to be two explanations of the variation in "time." Either the



baking quality of the f.a.q. samples for the various seasons varied in this manner or the known improving effect of age on quality has increased the Pelshenke time to a maximum at about 12 years age and further aging has caused deterioration.

The second explanation seems the more acceptable because (a) other quality tests carried out on the samples at the time of collection do not indicate such variation in quality ; (b) there is no comparable variation in "time" for the 1933-34 to 1936-37 samples tested at the time of collection, showing that the quality of the f.a.q. sample has not varied greatly during these four seasons; (c) for the 1933-34 and 1934-35 samples where the Pelshenke times of the fresh and of the aged samples can be compared there is a definite increase in "time" for the aged samples.

It is suggested, therefore, that under the conditions of storage obtaining at the time the baking quality of Western Australian f.a.q. wheat increased to a maximum after about 12 years' storage and then decreased. This can only be regarded as a suggestion and it is intended to continue this work to confirm or disprove the results obtained in this test.

An improvement with age for 12 years is a much longer time than is generally reported in the literature, which is about three to four years, though deterioration may not occur till more than six years after harvesting.

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THE INOCULATION OF TANGIER PEAS.

W. P. CASS-SMITH, B.Sc. Agr.,
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INTRODUCTION.

The inoculation of leguminous seed with pure cultures of the requisite strains of root nodule bacteria has been practised in Western Australia since 1926. During that year a culture for the inoculation of lucerne seed was obtained from the Rothamsted Experiment Station, England, and the distribution of subcultures to farmers was commenced. Since that time, in order to meet an increasing demand, other strains have been introduced from various sources, and during the last three years the number of pure cultures supplied to farmers has averaged more than 1000 per year.

The results obtained have on the whole been very successful, more especially as the majority of inoculated seed has been planted on land recently cleared of native vegetation, or on which cultivated leguminous plants have not previously been grown.

At the present time nine strains of the root nodule bacteria are kept in stock by the Plant Pathological Branch of the Department of Agriculture, each of which is considered to be effective for the inoculation of a group of closely related leguminous plants (cross-inoculation group), but ineffective for plants outside that group (1). In practice over a number of years this has proved to be the case, and good results have been obtained by using a single strain of the nodule bacteria, e.g., the "pea" strain, for the inoculation of such members of the group as garden, field and sweet peas, broad and tick beans and vetches, etc.

Strain of bacteria required for the inoculation of Tangier Pea.

Recently some doubt has been expressed by farmers who have used the pea culture concerning its effectiveness for the inoculation of Tangier pea (*Lathyrus tingitanus*), "a plant which shows great promise as a fodder plant, and for green manuring, in districts with a winter rainfall of 16 inches or over." (2).

As it is now well recognised that a strain of root nodule bacteria effective with one plant species may be somewhat less effective with other species of the cross inoculation group, it was deemed advisable, in view of the potential agricultural importance of the Tangier pea, to isolate an effective strain directly from this plant.

Isolation of Tangier Pea Strain.

Mr. A. T. O'Connell, of Dwarda, who has grown Tangier peas very successfully in his district for a number of years, was approached, and from his 1936 crop he kindly selected a number of very vigorous Tangier pea plants, each of which bore a few very large nodules on the tap root, a feature by which efficient strain may be recognised, according to the work of Allen and Baldwin (3).

From these specimens one very large nodule from the upper portion of the tap root was chosen, and using the method described by Thornton (4) a bacterial strain was isolated.

Field Trial with Tangier Pea Culture.

In order to test the effectiveness of the new strain, Mr. O'Connell again co-operated with this Department and on June 1st, 1937, a preliminary experiment consisting of three trial plots was seeded with Tangier peas as follows:—

Plot (a) Seed uninoculated.

Plot (b) Inoculated by broadcasting soil taken from an old paddock in which Tangier peas had previously grown successfully (soil transfer).*

Plot (c) Seed inoculated with a pure culture of the Tangier pea nodule bacteria.

The land selected for the trial was fallowed sandy loam on which neither field, garden nor Tangier peas had previously been grown, carrying in the virgin state sheoak, jam, redgum and whitegum.

A dressing of about $1\frac{1}{2}$ cwts. per acre of superphosphate was given to all plots and the sowing methods were such as to preclude as far as possible either the accidental introduction of the pure culture bacteria into plots (a) and (b) or their direct contact with the superphosphate.

RESULTS.

About the middle of October representative samples taken from each plot were forwarded by Mr. O'Connell to the Department of Agriculture for examination.

In addition to the greatly increased yield brought about by seed inoculation, another very marked feature was the variation in both size and number of nodules resulting from the different treatments.

The nodules on the specimens from plot (c) (inoculated with culture) were comparatively few in number, large in size and situated for the most part on the tap roots, whereas those from plot (b) (soil inoculation) were much more numerous, smaller in size and confined almost entirely to lateral rootlets Only one nodule could be found on the specimens from plot (a) (uninoculated).

Yield.

An officer of the Department of Agriculture who happened to be in the Dwarda district towards the end of October inspected the plots and reported that their growth was roughly in the following order of relative magnitude:—

Plot (a) No inoculation	1
Plot (b) Soil transfer inoculation	2
Plot (c) Seed inoculated with pure culture	4

Thus by inoculating the seed with the pure culture before planting, a yield approximately four times that of the uninoculated plot and double that of the soil transfer plot was obtained.

* This was Mr. O'Connell's usual method of inoculation, for in the past it had given better results than seed inoculation with the Pea Culture.

(a) (b) (c)

Tangier pea plants showing the effects of inoculation with nitrogen-fixing bacteria. The plants were grown in soil not previously cropped w'th legumes, (a) without any inoculation. (b) Inoculated by m ans of soil taken from an old paddock in which Tangier peas had previously grown successfully. (c) Inoculated by means of seed inoculation with a special bacterial strain isolated from Tangier pea roots.

The relative growth was estimated as being in the ratio of 1:2:4.

Photo. by Govt. Printer.

Chemical Analysis.

Representative samples were cut from each plot by Mr. O'Connell towards the end of the growing period, dried in the shade and subsequently analysed by the Government Analyst, with the following results:—

	Plot (a).	Plot (b).	Plot (c).
	%	%	%
Moisture	8.53	8.40	8.62
Nitrogen*	2.26	2.34	2.42
Ash	5.22	4.48	5.48
Cr. Protein (N x 6.25)	14.12	14.62	15.12

* Calculated on dry basis.

Although the figures for nitrogen content are approximately the same for each treatment, yet when the proportionate yields are taken into account the increased nitrogen fixation on Plot (c) is very considerable.

CONCLUSIONS.

Although it is realised that the field trial described had some limitations from an experimental point of view which in the circumstances were unavoidable, the following conclusions may be drawn:—

(1) A strain of Tangier pea nodule bacteria has been isolated which in a preliminary trial gave excellent results as compared with the usual soil transfer method adopted by one of the most successful and biggest scale growers of Tangier peas in W.A. This strain is now available to farmers planting Tangier peas at the usual charges.

(2) Unsuccessful results may be expected when uninoculated Tangier peas are planted in soil which has not previously grown this crop, or such plants as field or garden peas, broad or tick beans and vetches.

(3) Further work to compare the relative effectiveness of the "Pea" and Tangier pea strains is required. Unfortunately an experiment carried out last year at the Denmark Research Station to elucidate this point proved a failure, owing to the ravages of red mite.

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ROYAL AND DISTRICT AGRICULTURAL SOCIETIES' 50 ACRE CROP COMPETITIONS, 1937.

I. THOMAS,
Superintendent of Wheat Farming.

Fifty acre crop competitions were commenced in this State in 1921. Their object is to improve the farming methods of the State by creating a spirit of healthy rivalry among farmers and by focussing attention upon the methods of the successful competitors. They also enable farmers to make personal contact with the officers attached to the Wheat Branch of the Department who have been judges since the inception of the competitions.

Entry for these competitions is made through the local Agricultural Societies, the first and second prize winners of each local competition automatically becoming eligible to compete for the Royal Agricultural Society's zone prize. Where no local competition is conducted, entry is accepted direct with the Royal Agricultural Society and in this way no farmer desirous of doing so is prevented from participating.

On account of the great variation in soil and climatic conditions, the wheat-belt has been divided into eight zones in such a manner that districts having similar interests and climatic conditions are grouped together. In this way farmers compete with each other more equitably. The accompanying map shows the eight zones referred to.

In each zone a championship prize of £10 and a second prize of £2 10s. are awarded.

In addition to these prizes, the Royal Agricultural Society offers a special prize of £5 5s. to the competitor, in any zone, who obtains the highest calculated bushel yield per acre.

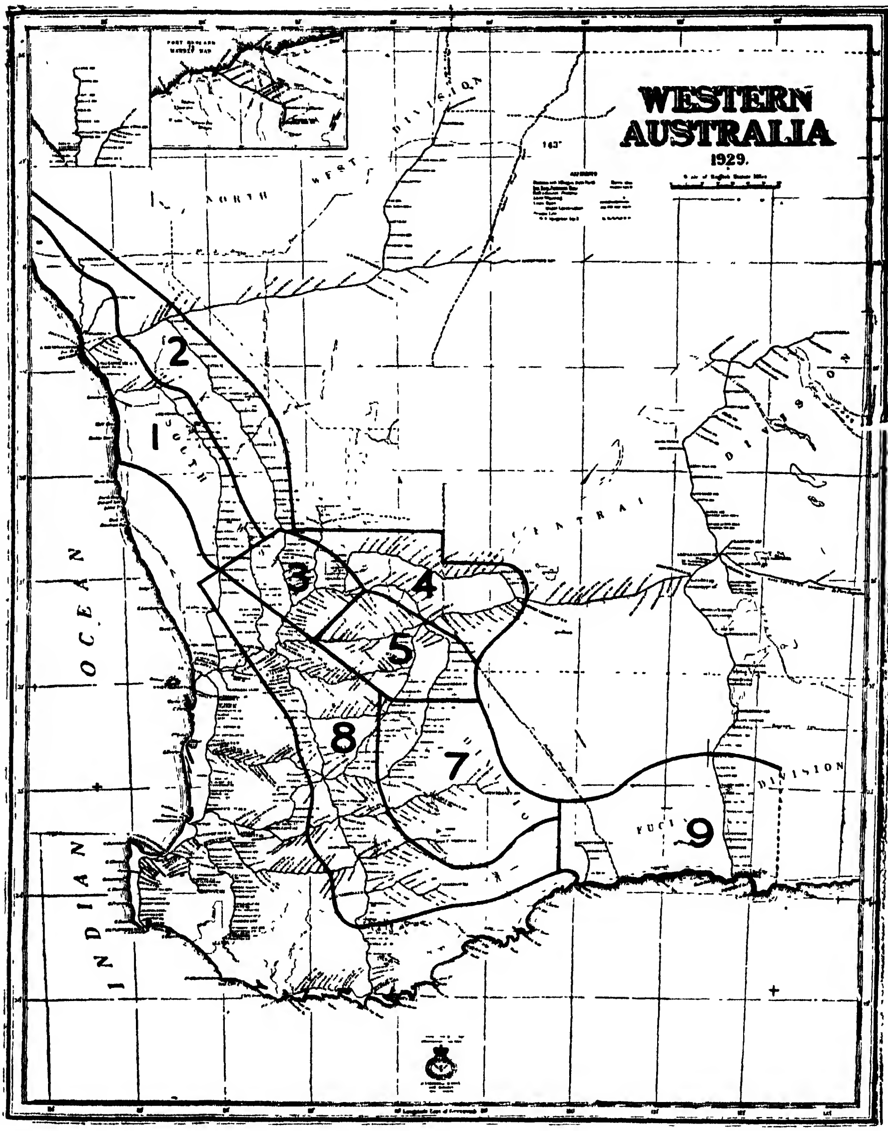
The conditions of the competitions require that the crop shall be grown on fallowed land, shall be not less than 50 acres in area of one variety, and shall be judged under the following scale of points:—

Yield	50 points
Freedom from weeds	10 „
Freedom from disease	10 „
Freedom from admixture	15 „
Evenness of growth	15 „
Total	100 points

The system is to allot one point for each bushel of the calculated yield per acre, which is determined by taking quadrate samples systematically throughout the crop, threshing and weighing the grain.

The 1937 season commenced well for all the wheat belt areas, excepting the North Eastern districts, with very good general rains during the third week of April. The less fortunate Eastern and North Eastern areas had to wait another

month for their first good rains which fell during the third week of May. These rains were the heaviest and most widespread that have been recorded for some years and at the end of May conditions were looking very promising for the whole of the Western Australian wheat belt.



Patchy June rains followed by an unusually long dry spell throughout July and early August reduced crop prospects in all centres and particularly in the Eastern and North Eastern areas, where soil moisture has been steadily depleted over three consecutive dry seasons. The dry spell terminated with general rains during the latter part of August and though rains thereafter were scanty some good yields have been obtained—particularly in the Southern areas.

The detailed awards made in each zone are as follows:—

ZONE 1.

Judge: N. Davenport, B.Sc. (Agric.), Agricultural Adviser.

Competitors: Three Springs, 4; Carnamah, 12; Royal, 1. Total, 17.

The rainfall recorded at Moora, Carnamah, Three Springs and Greenough is shown in the following table:—

——	Jan.	Feb.	Mar.	Apl	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Moora	....	....	74	130	308	349	84	329	177	13	1,260	77	....	1,541
Carnamah	31	.	...	170	372	236	66	252	90	5	1,021	16	....	1,238
Three Springs	17	5	.	158	331	280	61	264	83	7	1,026	21	4	1,231
Greenough ...	5	.	8	132	385	438	80	309	100	56	1,368	43	8	1,564

Tables showing the Judge's awards and details of the treatment received by the leading crops are given below.

CARNAMAH AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Catta, G. ..	Carnamah	Ford	32	9	9	13	13	76
Clarke, R. W. .	do.	Sutton	30	9	9	14	13	75
Diamond, R McW.	do.	Gluyas Early	29	8	9	14	13	73
Forrester, J. K.	do.	Merredin	29	8	9	14	13	73
Clarke, R. W. (jnr.)	do.	Nabawa	27	9	9	14	13	72
Bothe, B. D.	Coorow	Bencubbin	27	8	9	14	13	71
Rooke, F.	Carnamah	Merredin	27	9	9	14	12	71
Niven, R.	do.	Gluyas Early	27	9	8	14	12	70
Sargent, W. A. T.	do.	Merredin	25	9	8	14	14	70
Sivyer, K. J.	do.	Nabawa	27	9	9	13	12	70
Roberts, I. B. ...	Coorow	Waratah	19	9	9	13	14	64
Aunger, M. S. ...	Carnamah	Totadgin	21	8	7	12	12	60

Mr. G. Catta's winning crop of Ford was grown on salmon gum and gimlet country which had been cleared for many years. The land was ploughed to a depth of 4in. in June and July with a mouldboard plough and cultivated with a disc cultivating plough in September and again in October. It was planted with a disc drill during the first week of May, the rates of seed and superphosphate being 45 and 80 lbs. respectively.

Mr. R. W. Clarke's entry which obtained second place was a crop of Sutton grown on York gum and jam country which had been disc ploughed in mid-July to a depth of 4in. and cultivated with a disc cultivating plough in September. It was sown during the first week of May with a combined cultivator-drill, using 45 lbs. of seed and 100 lbs. of superphosphate per acre.

Mr. R. McW. Diamond's crop of Gluyas Early was grown on York gum, salmon gum and gimlet country which had been disc ploughed in July and again in September and cultivated with a disc cultivating plough—part in October and part in April. It was planted with a combined cultivator-drill in early May using 50 lbs. of seed and 100 lbs. of superphosphate per acre.

THREE SPRINGS AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Lynch, Senator P. J.	Three Springs....	Bencubbin	30	9	9	14	13	75
Turner Bros.	Arrino	Gresley	28	8	9	14	13	67
Connaughton, F.	Three Springs....	Gluclub	25	9	9	12	11	66
Hebiton, J. K.	do.	Pusa	22	8	9	13	12	64

Senator P. J. Lynch's winning entry of Bencubbin was grown on land which had originally carried salmon gum and York gum. It was ploughed in July to a depth of $4\frac{1}{2}$ inches with a mouldboard plough and worked back with a disc cultivating plough in May. It was planted during the second week of June with a combined cultivator drill, 60 lbs. of seed and 60 lbs. of superphosphate being applied per acre.

Turner Bros.' crop of Gresley was grown on land which had carried York gum, mallee and tamma. It was disc-ploughed 3 inches deep in September and cultivated with a disc cultivating plough prior to sowing with a disc drill in early May. 60 lbs. of seed and 75 lbs. of superphosphate were applied per acre.

Mr. F. Connaughton's crop of Gluclub was grown on country similar to Senator P. J. Lynch's and received similar treatment. It was seeded, however, during the third week of June and the rates of seed and superphosphate were 60 and 80 lbs. respectively.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts	15 pts	15 pts.	100 pts
Hockridge, W. J.	Moora	Royal	Sword	31	9	9	14	14	77
Catta, G	Carnamah	Carnamah	Ford	32	9	9	13	13	76
Clarke, R. W.	do.	do	Sutton	30	9	9	14	13	75
Lynch, Senator P J	Three Springs	Three Springs	Bencubbin	30	9	9	14	13	75
Morrell Bros.	Greenough	Royal	Toby's Tusk	29	9	9	14	13	74
Turner Bros	Arrino	Three Springs	Gresley	23	9	8	14	13	67

Mr. W. J. Hockridge's crop of Sword, which won the Zone prize of £10, was grown on land which originally carried York gum, jam, and white gum. It was ploughed 4 inches deep in June with a mouldboard plough and springtyne cultivated after rains in April. It was seeded during the second week of May with a combined cultivator drill applying 60 lbs. of seed and 90 lbs. of superphosphate per acre.

ZONE 2.

Judge: N. Davenport, B.Sc.(Agric.), Agricultural Adviser.

The seven competitors in this zone all entered direct with the Royal Agricultural Society.

The rainfall recorded at Damboring was as follows:—

——	Jan.	Feb.	Mar.	Apl	May.	June	July.	Aug	Sept.	Oct	Total	Nov	Dec.	Total for Year.
					Growing Period.									
Damboring ...	8	35		47	223	239	40	234	65	56	857	95	....	1,042

The awards made are tabulated below:—

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts
Lyon, L. D. & O. M.	East Damboring	Royal ..	Bencubbin	25	9	9	14	13	70
Sutcliffe, J. & G.	do.	do.	Gluclub	24	9	9	14	13	69
Meadows, T. C.	do.	do .	do. .	24	8	8	14	14	68
Harrington S. C.	do.	do. .	do.	23	9	9	13	13	67
McKay & McKay	do.	do. .	do.	22	9	9	14	12	66
Bradford, R. ...	do.	do .	Bencubbin	20	9	9	14	13	65
Bradford, L. ...	do.	do. .	do.	21	9	9	13	12	64

The winning crop of Bencubbin grown by Messrs L. D. and O. M. Lyon was on land which had carried morrel and scrub. It was ploughed 4 inches deep in late July, cultivated in September with a springtyne implement and again in early May with a disc cultivating plough. It was planted with a combined cultivator-drill during the last week of May, the rates of seed and superphosphate being 45 lbs. and 100 lbs. respectively.

Messrs. J. and G. Sutcliffe's crop of Gluclub, which was awarded second place, was grown on land which had carried salmon gum and gimlet. It was ploughed 4½ inches in July, 1936, and cultivated with a springtyne implement in August and September and again in May. It was planted late in May with a combined cultivator drill, 34 lbs. of seed and 100 lbs. of superphosphate being applied.

Mr. T. C. Meadow's entry of Gluclub on similar country was disc ploughed 4 inches deep in July, springtyne cultivated in August and September and planted at the end of May with a combined cultivator-drill, the rates of seed and superphosphate being 40 lbs. and 100 lbs. respectively.

ZONE 3.

Judge: F. L. Shier, B.Sc.(Agric.), Agricultural Adviser.

Competitors: Ballidu, 7; Wyalkatchem, 2, Royal, 7. Total, 16.

The rainfall for the year at the centres concerned in the Zone 3 competition is shown below:—

——	Jan.	Feb.	Mar.	Apl	Growing Period. May.	June	July	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Wongan Hills		5	102	112	296	199	32	203	50	20	800	171		1,190
Ballidu	7	20	13	46	263	194	40	250	72	34	853	90		1,029
Goomalling		6	7	84	220	217	84	210	31	11	773	94	2	966
Calingiri		11	29	132	304	356	94	306	80	14	1,154	62		1,388
Minnivale		12	25	56	308	271	31	197	51	12	870	30		993
Cowcowing	22	15	3	35	246	175	29	190	55	11	706	70		851

The awards made are set out below:

BALLIDU AGRICULTURAL SOCIETY

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts	10 pts.	10 pts.	15 pts.	15 pts.	100 pts
Ackland, H.	Wongan Hills	Bencubbin	30	9	9	14	13	75
Knapp, J.	Ballidu	do.	29	8	9	14	13	73
Thomas, W.	do.	Gluclub	28	8	9	13	13	71
Goodie, H.	do.	Golden King	28	9	7	14	13	71
Petchell, R.	do.	Gluclub	25	9	9	13	13	69
Beilby, A.	do.	Bencubbin	23	8	9	14	13	67
Nelson, F.	do	do.	22	8	9	12	13	64

The winning crop of Bencubbin entered by Mr. H. Ackland was grown on jam and York gum country. It was ploughed in early June, 1936, with a mouldboard plough and cultivated in September and in May with a springtyne cultivator. It was seeded during the 3rd week of May, the rates of seed and superphosphate being 50 and 120 lbs. respectively.

Mr. J. Knapp's crop of Bencubbin was planted on land which had carried salmon gum, gimlet and morrel. It was ploughed in June with a disc cultivating plough and cultivated in September and again in early January. Seeding was carried out on the 23rd of May, and 45 lbs. of seed and 90 lbs. of superphosphate were applied per acre.

Mr. W. Thomas' crop of Gluclub was on land which had carried gimlet and scrub and which had been ploughed in July with a disc cultivating plough and

springtyne cultivated in September. It was seeded during the last week of May at the rate of 48 lbs. per acre. Superphosphate was applied at 120 lbs. per acre.

WYALKATCHEM AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Lawrence, A. E.	Benjaberring	Rajah	25	9	9	13	13	69
Lehman, C. E. ...	Cowcowing	Bencubbin	18	9	9	14	14	64

The winning crop, grown by Mr. A. E. Lawrence, was on land which had carried salmon gum and scrub, and had been ploughed with a disc implement in July and springtyne cultivated in September and again in April. Seeding was carried out during the 3rd week of May, the rates of seed and superphosphate being 36 and 120 lbs. respectively.

Mr. C. E. Lehman's crop as on country which had carried mixed timbers, mallee and scrub, and had been farmed for five years. It was disc ploughed in late July, scarified in September and seeded at the middle of May with a combined cultivator-drill. Seed and superphosphate were applied at 45 and 85 lbs. per acre respectively.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts	15 pts.	100 pts.
Ackland, H.	Wongan Hills	Ballidu	Bencubbin	30	9	9	14	13	75
Knapp, J.	Ballidu	do	do.	29	8	9	14	13	73
Johnson, F. B., & Sons	Goomalling	Royal	do.	28	9	9	13	13	72
Edmonds, B. J.	Calcarra	do.	Nabawa	28	9	7	14	13	71
Waterhouse, E J	Goomalling	do.	Bencubbin	26	9	9	13	14	71
Hughes, J. R	Minnivale	do.	do.	26	9	9	14	13	71
Lawrence, A E.	Benjaberring	Wyalkatchem	Rajah	25	9	9	14	13	70
Vallence, H.	Minnivale	Royal	Bencubbin	24	9	9	14	13	69
Hesford, T W	do	do.	Gluclub	24	9	9	13	14	69
Williams, J. D.	Piawaning	do.	Nabawa	22	9	9	14	13	67
Lehman, C. E.	Cowcowing	Wyalkatchem	Bencubbin	18	9	9	14	14	64

Messrs. F. B. Johnson and Sons' crop of Bencubbin, which was awarded third place in the Zone competition, was grown on land which had carried York gum, salmon gum and jam, and had been ploughed with a mouldboard plough in June and cultivated in September and in May with a springtyne cultivator. Seeding was done in mid-May, the rates of seed and of superphosphate being 70 and 90 lbs. per acre respectively.

ZONE 4.

Judge: W. M. Nunn, B.Sc.(Agric.), Agricultural Adviser.

Competitors: Mt. Marshall, 5; Nungarin and Eastern Districts, 6. Total, 11.

The rainfall for the year recorded at Nungarin, Bencubbin, Yorkrakine and Gabbin is set out below:—

——	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Nungarin ..	32	15	44	42	238	132	52	174	37	21	654	69	3	859
Yorkrakine	..	1	8	38	239	179	50	177	37	15	697	54		798
Bencubbin ...	57	3	52	46	211	126	29	164	36	17	583	83	.	824
Gabbin	91	13	21	32	212	110	44	229	67	28	690	49	.	896

The awards made are set out below, and descriptions are given of the treatment received by the leading crops.

MT. MARSHALL AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Hopwood, B. W. G.	Bencubbin	Bencubbin	18	8	9	14	14	63
Purdom, B. .	do.	do.	17	6	9	14	13	59
Mill, J.	Gabbin	Totadgin	14	8	7	14	12	55
Perry Bros. ...	Bencubbin	Gluyas Early	10	9	8	14	12	53
Gobbart, W., & Sons	Gabbin ...	Bencubbin	12	5	9	14	12	52

Mr. B. W. G. Hopwood's winning crop of Bencubbin was grown on land which had carried mallee and scrub and was disc ploughed 3 inches deep in June, springtyne cultivated in early August and seeded on the 7th of May. Seed and superphosphate were applied at 45 and 120 lbs. per acre resepectively.

Mr. B. Purdom's crop—also of Bencubbin—was on land which had carried salmon gum, gimlet, mallee and scrub, was disc-ploughed 3 inches deep in August, springtyne cultivated in September and seeded during the third week of May, 45 and 90 lbs. being the rates of seed and superphosphate respectively.

Mr. J. Mills' crop of Totadgin, which occupied third place, was on land which three years ago carried mallee and scrub. It was disc-ploughed 4 inches deep in late July and disced again in April to cut out scrub. Seeding was carried out during the second week of May, 50 lbs. of seed and 100 lbs. of superphosphate being applied.

NUNGARIN AND EASTERN DISTRICTS AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Fitzpatrick, R. C.	Nungarin	Bencubbin	22	8	9	14	12	65
Diver, L. C. .	Yelbeni	. Totadgin	20	9	9	14	12	64
Bodey, W., & Sons	Nungarin	Bencubbin	18	8	9	12	12	59
Creagh Bros .	do.	Noongaar	17	7	8	14	13	59
Jolly, H. P.	do.	Bencubbin .	17	8	9	14	11	59
Watson Bros.	do. ...	Noongaar .	13	6	9	14	10	52

Mr. R. Fitzpatrick's winning crop of Bencubbin was on jam and mallee country which had been under cultivation for 12 years but left out for several consecutive years prior to fallowing in 1936. It was disc-ploughed 3 inches deep in early June and seeded during the first week of May, 45 lbs. of seed and 100 lbs. of superphosphate being applied.

Mr. L. C. Diver's crop of Totadgin, which was awarded second place, was on land which had carried salmon gum, gimlet and mallee. It was disc-ploughed 3 inches deep in early June, springtyne cultivated in July and again in September and seeded during the fourth week of May. Seed and superphosphate were applied at the rate of 60 and 80 lbs. per acre respectively.

Messrs. W. Bodey and Sons' crop of Bencubbin was on similar country which had been cultivated with a rigid tyne scarifier to a depth of 3 inches in July and re-scarified in September and seeded during the fourth week of May, 40 lbs. and 100 lbs. per acre being the rates of seed and superphosphate respectively.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Fitzpatrick, R. C.	Nungarin	Nungarin and Eastern Districts	Bencubbin	22	8	9	14	12	65
Diver, L. C. ...	Yelbeni ..	do.	Totadgin .	20	9	9	14	12	64
Hopwood, B. W. G.	Bencubbin .	Mt. Marshall	Bencubbin	18	8	9	14	14	63
Purdom, B. .	do. .	do.	do.	17	6	9	14	13	59

ZONE 5.

Judge: W. M. Nunn, B.Sc.(Agric.), Agricultural Adviser.

Competitors: Bruce Rock, 8; Merredin, 6. Total, 14.

The rainfall for the year recorded at Bruce Rock, Merredin, Burracoppin and Erikin is as follows:—

——	Jan.	Feb.	Mar.	Apl.	Growing Period — May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Bruce Rock	4	9	47	61	223	144	45	231	49	37	729	154	4	1,008
Merredin	20	8	49	60	235	164	46	198	45	29	717	78	10	937
Burracoppin .	16		103	71	249	145	36	166	53	32	681	156	10	1,037
Merredin Research Station	25	6	31	31	206	164	37	155	47	28	637	96	6	832

The detailed awards are set out below:—

BRUCE ROCK AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Ellis, E. G. & M. P.	Ardath	Bencubbin	25	9	9	11	13	67
Perkins, C. C.	Belka	do.	19	8	9	14	14	64
Jones, R.	Shackleton	Gluclub	20	9	9	12	13	63
Garrett, G.	Ardath .	do. .	19	9	8	13	13	62
Starcevitch, J.	Korbel	Bencubbin	18	9	9	12	13	61
Butler, W. J.	Bruce Rock	do.	19	8	9	11	13	60
Fuchsbichler, M.	do .	do.	16	8	9	11	11	55
Spiller, H.	Erikin	Pusa 4	13	9	9	10	12	53

The winning crop entered by Messrs. E. G. and M. P. Ellis was a crop of Bencubbin grown on salmon gum and jam country. It was disc-ploughed 3 inches deep in June, springtyne cultivated in August, harrowed in September and seeded during the third week of May, 60 lbs. of seed and 90 lbs. of superphosphate being applied per acre.

Mr. C. C. Perkins' crop of Bencubbin was on land which had carried jam and scrub. It was rigid-tyne scarified 2½ inches deep in June, springtyne cultivated in August and again in September. It was seeded during the third week of May, 45 and 115 lbs. respectively of seed and superphosphate being applied per acre.

Mr. R. Jones' crop of Gluclub was grown on salmon gum and gimlet country which was disc-ploughed 3½ inches deep in June and springtyne cultivated in August, October and April. It was seeded during the fourth week of May, the rates of seed and superphosphate being 45 and 90 lbs. per acre respectively.

MERREDIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Thyne, T. K.	Norpa	Bencubbin ...	20	8	9	14	13	64
McPharlin, E. B., & Sons	South Burracoppin	do. ...	19	8	9	14	12	62
Harling, H.	Belka	Totadgin ...	17	9	9	14	12	61
Flockart, I. H.	Merredin	Bencubbin ...	16	8	9	14	12	59
Barnett, L. T. C.	Walgoolan	do.	14	7	8	12	10	51
Robartson, R.	Nangeenan	Totadgin	12	8	9	12	9	50

Mr. T. K. Thyne's winning crop of Bencubbin was grown on land which had carried mallee and scrub. It was disc-ploughed to 3½ inches in June and spring-tyne cultivated in August and seeded 1st of May, 45 lbs. of seed and 90 lbs. of superphosphate being applied.

Messrs. E. B. McPharlin and Sons' crop of Bencubbin was grown on gimlet and mallee country which had been cleared for eight years, rigid-tyne scarified 3 inches deep in June, rescarified in August and again in September. It was seeded in mid-May, the rates of seed and superphosphate being 45 and 120 lbs. respectively.

Mr. H. Harling's crop of Totadgin was on land which had carried salmon gum and gimlet. It was rigid-tyne scarified in June and again in August. Seeding was done on the 28th of May, the rates of seed and superphosphate being 42 and 112 lbs. per acre respectively.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Ellis, E. G. & M. P.	Ardath	Bruce Rock	Bencubbin	25	9	9	11	13	67
Thyne, T. K.	Norpa	Merredin	do.	20	8	9	14	13	64
Perkins, C. C.	Belka	Bruce Rock	do.	19	8	9	14	14	64
McPharlin, E. B., & Sons	South Burracoppin	Merredin	do.	19	8	9	14	12	62

ZONE 7.

Judge: A. S. Wild. B.Sc.(Agric.), Agricultural Adviser.

Competitors: Kukerin, 9; Karlgarin, 9; Lake Grace, 12; Kulin, 17. Total, 47.

The rainfall for the year recorded at Kukerin, Karlgarin, Kondinin, Kulin and Lake Grace is set out below.—

——	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Karlgarin ..	.		225	43	190	186	20	214	24	31	665	141	....	1,074
Kukerin .		2	420	114	357	301	109	265	76	59	1,167	205	6	1,914
Lake Grace	2		392	79	290	260	50	248	38	28	914	162	10	1,559
Kondinin ...			81	70	312	245	34	184	37	34	846	120		1,117
Kulin		2	115	99	320	188	43	253	56	41	901	189	...	1,306

The detailed awards and treatments received by the leading crops are given below.

KUKERIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
English, A. R.	Kukerin ...	Bencubbin ...	41	9	9	12	14	85
Bairstow, F. ..	Moulyinning	Gluclub .	38	9	8	13	14	82
Bahr, O. E.	Merilup ...	Yandilla King	37	9	8	13	13	80
Faulkner, W. J.	North Kukerin	Bencubbin ..	31	8	9	14	14	76
Morris, P.	Moulyinning ...	Gluclub	33	9	8	13	13	76
English, J. C.	Merilup	Bencubbin	31	8	9	12	13	73
Ditchburn, S.	Tarin Rock	Free Gallipoli ..	28	9	9	12	14	72
Gard, Wm.	Merilup	Gluclub ...	28	9	7	13	13	70
Nenke, B. ...	Kukerin ..	Bencubbin ...	27	8	8	14	13	70

Mr. A. R. English's crop of Bencubbin which won the Zone prize and also the special prize for the highest calculated yield per acre, was grown on land which had originally carried York gum and jam. It was scarified to a depth of 2 inches in June and received the same treatment in August and again in March. It was seeded during the second week of May with a combined cultivator-drill, the rates of seed and superphosphate being 45 and 95 lbs. per acre respectively.

Mr. F. Bairstow's crop of Gluclub was on land which had carried morrel and salmon gum. It was scarified in August to a depth of 3 inches and again in September, and received the same treatment just prior to seeding with a combined cultivator-drill during the second week of June. Seed and superphosphate were applied at the respective rates of 54 and 98 lbs. per acre.

Mr. O. E. Bahr's crop of Yandilla King was grown on land which had carried York gum, salmon gum and morrel and was ploughed 3 inches deep with a mouldboard plough, scarified in September and springtyne cultivated in April. It was seeded with a combined cultivator-drill during the first week of May, the rates of seed and superphosphate being 45 and 50 lbs. per acre respectively.

KARLGARIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
James, S. W. ..	Karlgarin	Benecubbin	26	8	9	14	13	70
Richter Bros.	do.	do.	24	9	9	14	13	69
Finemore, A.	do	do. ...	26	8	9	12	13	68
Shawyer, C.	do.	do.	23	8	9	13	13	66
Spurr, E. F.	do.	Gluyas Early	22	8	9	12	13	64
Trestrail, S. J. ...	do.	Benecubbin	21	8	9	13	13	64
Marshall, H. J. ..	Hyden	do.	21	8	9	13	12	63
Medcalf, C. W. ..	Karlgarin	do.	22	8	9	12	12	63
Walton, A. H. ...	do.	do. ..	17	8	9	13	12	59

Mr. S. W. James' winning crop of Benecubbin was grown on salmon gum, morrel and mallee country which had been cropped five times previously. It was scarified in early July to a depth of $2\frac{1}{2}$ inches, received the same treatment in September and was scarified 2 inches deep in March. It was seeded with a combined cultivator-drill during the second week of May, 45 lbs. of seed and 90 lbs. of superphosphate being applied per acre.

Richter Bros.' crop of Benecubbin was on land which originally carried salmon gum, gimlet and mallee. It was ploughed $3\frac{1}{2}$ inches deep with a mouldboard plough, scarified to $3\frac{1}{2}$ inches in July and scarified to 2 inches in August and in March. Seeding was done with a combined cultivator-drill during the fourth week of May, 50 lbs. of seed and 110 lbs. of superphosphate being applied per acre.

Mr. A. Finemore's crop of Benecubbin was the eighth crop to be grown on the land which carried gimlet, salmon gum and mallee. It was disc ploughed 4 inches deep in early June and springtyne cultivated in August. It was disced to 2 inches in September, springtyne cultivated in March and planted with a combined cultivator-drill during the fourth week of May, the rates of seed and superphosphate being 43 and 120 lbs. per acre respectively.

LAKE GRACE AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Kay, W. H. & F. C.	Lake Grace	Gluclub	38	9	7	12	14	80
Darby, A. H. ...	do.	Bencubbin ..	31	9	9	13	13	75
Bishop, S. J. ...	do. ...	do. .	29	9	9	13	14	74
Carruthers, R. (jun.)	do.	Gluclub .	32	7	8	13	14	74
Bennett, E. W.	do. ...	Totadgin	27	8	9	14	14	72
Carruthers, W.	South Lake Grace	Bencubbin	29	9	8	12	14	72
Coad, H. J.	Lake Grace	do.	28	9	9	13	13	72
Kealley, E. E.	South Lake Grace	do. ..	27	9	8	13	13	70
Betham, W.	Lake Grace	Gluyas Early	27	8	8	12	13	68
Fry, E. H.	North Lake Grace	Bencubbin	26	8	8	13	13	68
Jones, G. & D.	Lake Biddy	do. ...	25	9	8	13	13	68
Morton, W. K.	do.	do. ..	28	8	7	12	13	68

The winning crop entered by Messrs. W. H. and F. C. Kay was grown on land which had carried salmon gum, morrel and gimlet. It was scarified in July to a depth of 3-3½ inches and again in August to a depth of 2 inches. It was springtyne cultivated in March and seeded in mid-April with a combined cultivator-drill, 50 lbs. of seed and 100 lbs. of Superphosphate being applied per acre.

Mr. A. H. Darby's crop of Bencubbin was on salmon gum and gimlet country which had been scarified 2-2½ inches deep in December, 1935, disc ploughed 3 inches in July and scarified in August. It was springtyne cultivated in September and again in October and seeded during the first week of May with a combined cultivator-drill. The rates of seed and superphosphate were 50 and 112 lbs. per acre respectively.

Mr. S. H. Bishop's entry of Bencubbin was grown on salmon gum and gimlet country which had been disc ploughed 3 inches deep in July and again late in August. It was springtyne cultivated in March and disced 2 inches deep before planting in the second week of May with a combined cultivator-drill. The rates of seed and superphosphate used were 45 and 120 lbs. per acre respectively.

KULIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Biggin, H.	Kondinin	Totadgin	31	9	9	13	14	76
Stubbs, W.	do.	Bencubbin	31	9	9	12	14	75
Gray, J. S.	Kulin	Gluclub	31	8	8	12	14	73
Clayton, R., & Sons	Jitarning	Sword	30	8	8	13	13	72
Evans, H	Kulin Rock	Bencubbin	28	9	9	13	13	72
Bele, J. H.	do.	do.	28	8	9	12	13	70
Bowey, P. J.	Kulin	do.	27	8	8	13	13	69
Freebairn, F. S.	Kulin Rock	Gluclub	26	9	8	12	14	69
Gordon, C. G.	Kulin	Bencubbin	25	9	9	12	14	69
Gray, J. S. (Mittakeri)	Jilakin	do.	25	9	9	13	12	68
Eyres, T.	Jitarning	Totadgin	24	9	9	13	12	67
Gamble, A. J.	Kondinin	Bencubbin	26	8	9	11	13	67
McInnes & Ryan	Kulin	Queen Fan	25	8	8	13	13	67
Bartlett, J.	do.	Bencubbin	23	9	8	13	13	66
McGrath, M.	Kulin Rock	Rajah	25	8	8	12	13	66
Meikle, P.	do.	Bencubbin	23	8	9	13	13	66
Riseborough, A.	Jilakin	do.	25	8	8	13	12	66

Mr. H. Biggin's winning entry of Totadgin was grown on land which had carried salmon gum, gimlet and mallee. It was disc ploughed 3-4 inches deep in early July, scarified in early September and planted with a combined cultivator-drill during the first week of May. 45 lbs. of seed and 100 lbs. of superphosphate were used per acre.

Mr. W. Stubbs' crop of Bencubbin was the seventh crop grown on an area of salmon gum, York gum, jam and gimlet country which was disc ploughed 3 inches deep in June and springtyne cultivated in August and September. It was sown with a combined cultivator drill during the third week of April, 48 lbs. of seed and 90 lbs. of superphosphate being added per acre.

Mr. J. S. Gray's crop of Gluclub was grown on mallee York gum, and jam country which was ploughed 3-3½ inches deep with a mouldboard plough. It was springtyne cultivated in September and planted with a combined cultivator drill during the fourth week of April. 60 lbs. of seed and 100 lbs. of superphosphate were used per acre.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts
English, A. R.	Kukerin	Kukerin	Bencubbin	41	9	9	12	14	85
Bairstow, F.	Moulyinning	do.	Gluclub	38	9	8	13	14	82
Kay, W. H. & F. C.	Lake Grace.	Lake Grace.	do.	38	9	7	12	14	80
Biggin, H.	Kondinin	Kulin	Totadgin	31	9	9	13	14	76
Darby, A. H.	Lake Grace	Lake Grace	Bencubbin	31	9	9	13	13	75
Stubbs, W.	Kondinin	Kulin	do.	31	9	9	12	14	75
James, S. W.	Karlgarin	Karlgarin	do.	26	8	9	14	13	70
Richter Bros.	do.	do.	do.	24	9	9	14	13	69

ZONE 8.

Judge: R. P. Roberts, B.Sc. (Agric.) Hons., Agricultural Adviser.

Competitors: Gnowangerup, 7; Wickepin, 5; Royal, 8. Total, 20.

The rainfall recorded at the centres concerned in this zone is as hereunder

——	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Gnowangerup	2		380	131	286	202	52	220	69	45	874	81	16	1,482
Wickepin		7	101	247	445	348	85	272	76	31	1,257	56		1,668
Yilliminning			246	153	325	303	107	300	61	51	1,147	51		1,597
South Caroling		12	10	146	311	164	35	180	36	50	776	149		1,093
Muresk	5	9	14	135	367	271	91	301	70	27	1,127	81		1,371
Toodyay		30	16	179	455	290	129	326	105	35	1,340	77		1,642
Broomehill	8	1	280	248	360	268	82	278	93	103	1,184	53	4	1,778
York	3	6	9	184	419	238	89	330	53	34	1,163	121		1,486
Noman's Lake		1	187	187	331	322	64	291	52	44	1,104	82		1,561
Borden	1	1	149	66	265	134	63	197	77	30	766	224	12	1,219

The awards and the particulars of the treatment received by the leading crops are as follows:—

GNOWANGERUP AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Aylmore, A. E.	Gnowangerup	Nabawa	37	9	9	14	13	82
Cockram, C. E.	do	Gallipoli	35	9	9	13	13	79
Garnett, V.	do.	Bencubbin	36	8	8	13	13	78
Stewart, W. B	Borden	do	33	9	9	13	13	77
McDonald, J. V. & A. R.	Gnowangerup	do.	33	8	7	13	11	72
White, R. H.	do.	do.	28	8	9	12	13	70
Formby, R., & Coy.	do.	do.	28	8	6	14	13	69

Mr. A. E. Aylmore's winning crop of Nabawa was grown on land which had carried York gum, white gum and salmon gum. It was ploughed with a mouldboard 3 inches deep in July and scarified in August and in May. Seeding was carried out in early June, 60 lbs. of seed and 90 lbs. of superphosphate being applied per acre.

Mr. C. E. Cockram's crop of Gallipoli was on morrel, York gum and salmon gum country which had been cleared four years and had been ploughed 3 inches deep with a mouldboard implement in July. It was springtyne cultivated in March and April and seeded on the 19th of May. The rates of seed and superphosphate were 55 and 130 lbs. per acre respectively.

Mr. V. Garnett's crop of Bencubbin was grown on York gum and morrel country which had been mouldboard ploughed 3½ inches deep in July, scarified in spring and springtyne cultivated in autumn. Seeding was carried out during the

fourth week of May, 52 lbs. of seed and 90 lbs. of superphosphate being used per acre.

WICKEPIN AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Dalton, L. J.	Wickepin	Bencubbin	35	8	9	13	13	78
McDonald, W. G.	Noman's Lake	do.	27	8	9	13	13	70
Fleay & Sons	Wickepin	do.	28	8	7	12	11	66
Pense, G.	do.	Dundee	24	7	8	13	12	64
Doncon, E.	do.	Bencubbin	22	7	8	13	12	62

Mr. L. J. Dalton's winning crop of Bencubbin was grown on salmon gum and gimlet country which had been cleared five years, ploughed with a mouldboard implement 3½ inches deep in August and springtyne cultivated in May. The crop was seeded during the third week of May, 70 lbs. of seed and 90 lbs. of superphosphate being used per acre.

Mr. W. G. McDonald's crop was on land which had carried morrel, York gum and jam. It was disc-ploughed to 2 inches in June, harrowed in September and springtyne cultivated three times in April and May. Seeding was carried out during the third week of May, 45 and 110 lbs. per acre being the respective rates of seed and superphosphate applications.

Messrs. Fleay & Sons' crop of Bencubbin was planted on morrel country which had been cleared for eight years, ploughed with a disc-cultivating plough in July and springtyne cultivated after the March rains. Seeding was carried out in mid-May, seed and superphosphate being applied at the rates of 60 and 90 lbs. per acre respectively.

ROYAL AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Aylmore, A. E.	Gnowangerup	Gnowangerup	Nabawa	37	9	9	14	13	82
Cockram, C. E.	do.	do.	Gallipoli	35	9	9	13	13	79
Dalton, J.	Wickepin	Wickepin	Bencubbin	35	8	9	13	13	78
Brooks, A. W.	East Narrogin	Royal	do.	34	8	9	14	13	78
Richards, A.	South Caroling	do	Totadgin	33	9	9	13	13	77
Boyle, T. K.	Greenhills	do.	Dundee	33	8	9	13	13	76
Burgess, W. G.	Burges Siding	do.	Bencubbin	32	8	9	14	13	76
Lloyd, C. J.	Toodyay	do.	Nabawa	33	8	8	12	14	75
Taylor, C.	Broomehill	do.	Bencubbin	32	8	9	13	13	75
Boyle, K. C.	York	do.	Merredin	31	9	8	11	14	73
Beeck, N. H.	Broomehill	do.	Gallipoli	32	8	8	12	12	72
McDonald, W. G.	Noman's Lake	Wickepin	Bencubbin	27	8	9	13	13	70

ZONE 9.

Judge: A. S. Wild, B.Sc. (Agric.), Agricultural Adviser.

The six competitors in this zone all entered through the Phillips River Agricultural Society.

The rainfall recorded at Ravensthorpe, Lake King and Mt. Short was as follows:—

					Growing Period.									
——	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Ravensthorpe....	8	9	381	46	148	280	61	277	199	91	1,056	250	5	1,755
Lake King	19	1	490	69	162	155	60	214	40	72	703	231	1	1,514
Mt. Short	4	3	302	46	114	130	61	243	132	44	724	186	....	1,265

The awards are set out in the following table:—

PHILLIPS RIVER AGRICULTURAL SOCIETY.

Competitor.	Address.	Society.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
				50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Daw, F. E.	Ravensthorpe	Phillips River	Gluclub	33	8	8	13	13	75
Bebbington Bros.	do.	do.	Bencubbin	29	8	8	13	13	71
Barrett, T. M.	do.	do.	Nabawa .	27	8	8	14	12	69
Chambers Bros.	do.	do.	do.	25	8	9	12	13	67
Atkins, G. H.	Lake King	do.	Bencubbin	20	8	9	13	13	63
Campbell, J. .	Mt. Short	do	do	19	7	8	14	12	60

Mr. F. E. Daw's winning crop of Gluclub was grown on salmon gum and gimlet country which had been cleared eight years and which was disc-ploughed 3½ inches deep in August, springtyne cultivated in October and again in April. Seeding was done during the first week of June, 45 lbs. of seed and 75 lbs. of superphosphate being applied per acre.

Messrs. Bebbington Bros.' crop of Bencubbin was grown on an area of salmon gum and mallee country which was disc-ploughed 3½ inches deep in July, springtyne cultivated in September, and seeded with a combined cultivator-drill in mid-May, 45 lbs. of seed and 90 lbs. of superphosphate being used per acre.

Mr. T. M. Barrett's crop of Nabawa was the third crop grown on an area of salmon gum and gimlet country which was disc-ploughed 3½ inches deep in July, springtyne cultivated twice in September and again in early April. Seeding was carried out with a combined cultivator-drill during the first week of May, 45 lbs. of seed and 95 lbs. of superphosphate being applied per acre.

ENTRIES.

Entries were received from 15 District Agricultural Societies, totalling 122 entrants. The Royal Agricultural Society received 16 entries direct, making the total number of competitors 138.

The following table shows the number and the average yield obtained each year since the competition was inaugurated:—

Year.	Number of District Agricultural Societies Competing.	Number of Competitors.	Average Yield of Competitors.	Average Yield for State.
1921	...	15	25	10.4
1922	...	32	24	8.9
1923	12	82	29	11.4
1924	15	70	31	12.8
1925	13	59	22.5	9.7
1926	11	99	24.5	12.0
1927	10	100	26.9	12.1
1928	13	114	22.5	10.1
1929	12	156	21.7	11.0
1930	15	165	27.4	13.3
1931	13	110	27.4	13.1
1932	17	168	29.3	12.3
1933	17	130	27.2	11.7
1934	17	114	26.8	9.8
1935	16	97	24.8	9.2
1936	12	80	21.0	8.4
1937	15	138	25.7	10.9*

* Estimate.

YIELDS.

The special prize of £5 5s. for the competitor obtaining the highest calculated yield per acre was awarded this year to Mr. A. R. English, of Kukerin, who obtained a yield of 41 bushels with the variety Bencubbin.

The winners of this prize to date are:—

	Bush. per Acre.
1925—Hebiton & Sons, Three Springs—Nabawa	34
1926—Cumming Bros., Carnamah—Yandilla King ..	38
1927—A. W. Parkinson, Gnowangerup—Yandilla King ..	40
1928—A. W. Parkinson, Gnowangerup—Yandilla King ..	40
1929—C. E. Cockram, Pallinup—Yandilla King	46
1930—C. Smith & Sons, Yarding—Gluclub	43
1931—H. O. Beeck, Gnowangerup—Yandilla King ..	42
1932—F. S. Freebairn, Jilakin—Gluclub	47
1933—D. Davis, Gnowangerup—Bencubbin	43
1934—C. E. Cockram, Pallinup—Free Gallipoli	40
1935—E. Davis, Gnowangerup—Bencubbin	41
1936—C. E. Cockram, Pallinup—Free Gallipoli	30
1937—A. R. English, Kukerin—Bencubbin	41

Of the 138 entries in this year's competition thirty-nine crops went 24 to 27 bushels; eight went 34-39 bushels; and one, the winner, went 41 bushels.

A list of the competitors who obtained 30 bushels and over is given below:—

Zone.	Competitor.	Address.	Society.	Variety.	Estimated Yield.
					bush.
7	English, A. R.	Kukerin ...	Kukerin ...	Bencubbin ...	41
7	Kay, W. H. & F. C. ...	Lake Grace...	Lake Grace...	Gluclub ...	38
7	Bairstow, F.	Moulyinning	Kukerin ...	do. ...	38
8	Aylmore, A. E.	Gnowangerup	Gnowangerup	Nabawa ...	37
7	Bahr, O. E.	Merilup ...	Kukerin ...	Yandilla King	37
8	Garnett, V.	Gnowangerup	Gnowangerup	Bencubbin ...	36
8	Cockram, C. E.	do.	do.	Gallipoli ...	35
8	Dalton, J.	Wickepin ...	Wickepin ...	Bencubbin ...	35
8	Brooks, A. W.	East Narrogin	Royal ...	do. ...	34
9	Daw, F. E.	Ravensthorpe	Phillips River	Gluclub ...	33
8	McDonald, J. V. & A. R.	Gnowangerup	Gnowangerup	Bencubbin ...	33
8	Stewart, W. B.	Borden ...	do.	do. ...	33
8	Lloyd, C. J.	Toodyay ...	Royal ...	Nabawa ...	33
8	Boyle, T. K.	Greenhills ...	do. ...	Dundee ...	33
8	Richards, A.	South Caroling	do. ...	Totadgin ...	33
7	Morris, P.	Moulyinning	Kukerin ...	Gluclub ...	33
8	Beeck, N. H.	Broomehill ...	Royal ...	Gallipoli ...	32
8	Taylor, C.	do.	do. ...	Bencubbin ...	32
8	Burgess, W. G.	Burges Siding	do. ...	do. ...	32
7	Carruthers, R. (jun.) ...	Lake Grace...	Lake Grace...	Gluclub ...	32
1	Catta, G.	Carnamah ...	Carnamah ...	Ford ...	32
8	Boyle, K. C.	York ...	Royal ...	Merredin ...	31
7	Gray, J. S.	Kulin ...	Kulin ...	Gluclub ...	31
7	English, J. C.	Merilup ...	Kukerin ...	Bencubbin ...	31
7	Faulkner, W. J. ...	North Kukerin	do. ...	do. ...	31
7	Stubbs, W.	Kondinin ...	Kulin ...	do. ...	31
7	Darby, A. H.	Lake Grace...	Lake Grace...	do. ...	31
7	Biggin, H.	Kondinin ...	Kulin ...	Totadgin ...	31
1	Hockridge, W. J. ...	Moora ...	Royal ...	Sword ...	31
7	Clayton, R. & Sons ...	Jitarning ...	Kulin ...	do. ...	30
3	Ackland, H.	Wongan Hills	Ballidu ...	Bencubbin ...	30
1	Lynch, P. J.	Three Springs	Three Springs	do. ...	30
1	Clark, R. W.	Carnamah ...	Carnamah ...	Sutton ...	30

THE COMPOSITION OF SOME GRASSES FROM TUREE CREEK STATION OF THE NORTH-WEST PASTORAL AREA OF WESTERN AUSTRALIA.

A. B. BECK[1] and E. J. UNDERWOOD[2].

A matter of considerable economic importance to Western Australia is a more accurate knowledge of the stock-carrying capacity of the North-West pastoral areas. Such information concerning the pastoral areas of Australia as is at present available has come almost entirely from a process of trial and error, a process that is not only costly and slow but in some cases leads to such serious consequences as permanent injury to the grazing from denudation following overstocking. Although accurate information must ultimately come from controlled experiments in the areas concerned, yet much information may be obtained by a systematic chemical examination of the pastures of those areas. Little or no analytical work had been done on the pastures of the North-West, so during 1933 and 1934 arrangements were made for the regular collection of a number of grasses from Turee Creek Station in the upper Ashburton Valley. This station is situated about 200 miles north of Meekatharra just south of the tropic of Capricorn. About 70 samples were collected at various times of the year and were submitted to the Government Botanist (Mr. C. A. Gardner) for classification. From these, thirty-one of the more important species were selected and submitted to the Government Chemical Laboratory for analysis. These analyses are now complete and are submitted with all available data for the information of those interested and to supplement any future investigations of the pastures of this area.

Results.—The results of the chemical analyses, together with brief descriptions of the samples as received, are presented in the folowing tables. A point that should be noted is that except where qualified by a note in the description of the samples, the analyses refer to the whole plants. The moisture figures are for the air dry grass, as received. All other figures have been calculated to a moisture free basis.

Aristida stipoides (Wind Grass).

Date sample taken	1933.				1934.		
	June.	July.	Aug.	Sept.	Feb.	Mar.	Apl.
Moisture (as received) ...	7·55	7·85	7·95	7·85	7·90	7·15	7·60
Crude Protein (N x 6·25)	3·2	3·7	3·8	3·1	6·6	6·2	6·2
Ether Extract	0·6	0·6	0·5	0·3	0·5	0·9	0·8
Crude Fibre	38·7	37·8	40·4	39·2	39·2	40·7	44·1
N Free Extract	47·5	47·1	46·4	48·5	43·0	40·6	39·3
Total Ash	10·0	10·8	8·9	8·9	10·7	11·6	9·6
Calcium (CaO)	0·31	0·25	0·42	0·31	0·42	0·28	0·52
Phosphorus (P_2O_5) ...	0·34	0·48	0·30	Trace	0·69	Trace	0·39
Chlorine (Cl)	0·40	0·27	0·29	0·25	0·31	0·26	0·31
Silica	8·5	9·6	7·7	8·1	8·6	10·4	7·3

Analyst—F. W. Steel.

[1] Acting Animal Nutrition Officer.

[2] Animal Nutrition Officer.

1933—

June ... ... Dry wiry grass. Many seed heads.

July ... ... About 9in. tall. Mostly dry but contained a little green. Dry seed heads contained some seed.

August ... ... 6in. to 9in. tall. Similar to previous sample.

September ... Practically all dry. A few half-green stems and leaves. Contains some whole plants cut close to ground. Carries seed heads, grain partially shed.

1934—

February ... About 9in. in height. Mostly green with seed heads containing seed.

March ... ... 6in. to 9in. high. Mostly dry, with some seed heads, grain partially shed.

April ... ... About 9in. Partly green with seed heads, grain partially shed.

Astrebla pectinata (Mitchell Grass).

Sample taken	1933.		1934.
	June.	July.	February.
Moisture (as received)	7·81	8·56	8·79
Crude Protein (N x 6·25)	3·5	4·4	8·9
Ether Extract	0·5	0·5	0·2
Crude Fibre	29·4	28·8	30·2
N Free Extract	54·0	51·8	48·1
Total Ash	12·6	14·5	12·6
Calcium (CaO)	0·24	0·25	0·36
Phosphorus (P_2O_5)	0·23	0·23	0·27
Chlorine (Cl)	0·20	0·20	0·73
Silica	10·4	10·3	9·5

Analyst—F. W. Steel.

1933—

June ... ... About 12in. high. Partly green leaves and stems. Very few seed heads.

July ... ... Mostly green leaves and stems. 9in. to 12in. Some mature stalks removed from sample Very few seed heads.

1934—

February ... Mostly green with green heads and seeds.

Chrysopogon Gryllus (Weeping Grass).

Sample taken ...	1933.				1934.		
	June.	Aug.	Sept.	Dec.	Jan.	Feb.	Mar.
Moisture (as received) ...	6·70	5·85	6·44	6·87	6·21	6·66	6·71
Crude Protein (N x 6·25)	4·1	4·9	3·9	1·8	6·3	4·0	7·9
Ether Extract	0·8	0·6	1·2	0·9	1·3	0·6	0·5
Crude Fibre	32·2	31·9	31·6	36·6	35·9	35·5	37·4
N Free Extract	46·5	52·2	49·4	50·0	44·7	46·3	43·9
Total Ash	16·4	10·4	13·9	10·7	11·8	13·6	10·3
Calcium (CaO)	0·39	0·77	0·48	0·24	0·25	0·19	0·63
Phosphorus (P_2O_5) ...	0·46	0·25	0·44	0·21	0·41	0·32	0·71
Chlorine (Cl)	0·26	0·22	0·20	0·23	0·26	0·22	0·55
Silica	9·3	7·6	11·9	9·5	9·9	12·8	5·5

Analyst—F. W. Steel.

1933—

June ...	... 15in. to 18in. high. Bottom half of grass dry and brown. Probably mature. Top 8in. to 9in. green leaf and stem. No flowering heads. Few inches of dry stem at bottom clipped off from sample.
August ...	... Tall grass 15in. high. Mostly green leaf and stem, but contains some tall dry pieces with partly green stem. No flowering heads in green portion, but dry portion has some dry seed heads containing no seed.
September	... Tall grass 18in. to 24in. Mostly green with full flowering heads. Some dry pieces removed.
December	... Tall dry grass with some seed heads. Seed partially shed.

1934—

January	... Tall grass 18in. to 20in. Mostly green, with green flowering heads.
February	... Tall grass 18in. Mostly green leaves and stems, with almost dry seed heads containing seed.
March ...	... 18in. to 20in. Half-green with some seed heads. Seed partially shed. Some dead stems removed from sample.

Eragrostis Brownii (Crabhole (Claypan ?) Grass).

Sample taken	1933. July.	1933. Aug.	1933. Sept.	1933. Dec.	1934. Mar.
Moisture (as received)	7·93	7·48	7·87	8·22	8·30
Crude Protein (N x 6·25) ..	4·1	3·8	3·3	3·2	11·7
Ether Extract	0·1	0·2	0·2	0·1	0·1
Crude Fibre	31·4	31·6	32·2	32·3	33·9
N Free Extract	53·0	50·0	51·0	55·0	43·0
Total Ash	11·4	14·4	13·3	9·4	11·3
Calcium (CaO)	0·34	0·34	0·31	0·48	0·48
Phosphorus (P_2O_5)	0·02	0·14	0·07	Trace	0·34
Chlorine (Cl)	0·09	0·12	0·10	0·12	0·36
Silica	10·3	13·0	11·8	7·6	7·9

Analyst—F. W. Steel.

1933—

July ...	... About 9in. tall. Mostly dry with a few green stems and leaves near base. Contains some empty seed heads.
August ...	... Mostly green but contains some dry leaves and stems.
September	... Mostly green with green flowering heads. 9in. to 12in. high.
December	... Dry grass 12in. tall with empty seed heads. No green stalks or leaves.

1934—

March ...	... Mostly green, 9in. in height. Contains seed heads with seeds.

Iseilema membranacea (Flinders Grass).

Sample taken	1934. March.
Moisture (as received)	8·11
Crude Protein (N x 6·25)	1·0
Ether extract	Trace
Crude fibre	36·1
N Free extract	50·0
Total ash	12·9
Calcium (CaO)	0·38
Phosphorus (P_2O_5)	0·55
Chlorine (Cl)	0·19
Silica	9·4

Analyst—F. W. Steel.

Small plants about 9in. high ; mostly green, some seed heads with seeds.

Themeda triandra (Kangaroo Grass).

Sample taken ...	1933.					1934.		
	June.	July.	Aug.	Sept.	Dec.	Feb.	Mar.	Apl
Moisture (as received) ...	6·67	4·56	7·19	8·00	8·05	10·33	8·41	8·34
Crude Protein (N×6·25)	2·7	2·8	3·2	4·1	2·4	4·1	3·7	4·2
Ether Extract	1·6	1·2	1·8	1·4	0·7	1·4	1·1	0·9
Crude Fibre	35·1	33·9	34·3	32·9	34·8	35·6	34·2	35·3
N Free Extract	49·5	51·1	46·6	47·2	52·9	47·8	45·4	40·7
Total Ash	11·1	11·0	14·1	14·4	9·2	11·1	15·6	18·9
Calcium (CaO)	0·24	0·21	0·24	0·48	0·32	0·31	0·27	0·57
Phosphorus (P_2O_5) ...	0·27	0·27	0·25	0·16	0·05	0·25	0·07	0·25
Chlorine (Cl)	0·23	0·31	0·21	0·30	0·16	0·41	0·28	0·26
Silica	9·1	9·1	12·3	12·6	7·6	9·2	14·1	13·6

Analyst—F. W. Steel.

1933—

June	Partly green leaves. Many dry flowering heads.
July	Tall plants 18in. to 20in. Dry at top, green leaves and stems at bottom. Some dry seed heads containing seed.
August	Tall plants 15in. to 18in. Dry stalks and leaves with green leaves 9in. long.
September ...	Tall plants, half-green, half-dry. A number of old dead pieces of stalk removed from sample analysed.
December ...	Tall dry grass, containing empty seed heads.

1934—

February ...	Partly green leaves and stems with seed heads containing seed. 18in. to 20in. in height.
March	Tall grass 20in. to 24in. Mainly dry stems and leaves. Seed partially shed.
April	Tall dry grass, dry flowering heads. Seed partially shed.

The rainfall for the period during which the grasses were collected is given in the following table:—

Rainfall Record—Turee Creek, W.A., January, 1933, *to June,* 1934.

1933—	Jan.	Feb.	March.	April.	May.	June.	
Rainfall (points) ...	10	5	300	88	123	5	
Days of rain	1	1	10	4	4	1	
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Rainfall (points) ...	83	105	11	0	0	87	817
Days of rain	1	3	1	0	0	3	29
1934—	Jan.	Feb.	March.	April.	May.	June.	
Rainfall (points) ...	236	139	560	158	10	16	
Days of rain	5	5	11	7	1	1	

Discussion.

A consideration of the analyses shows several outstanding points. Though the total ash is high, silica is the predominating constituent. The only other available figures for this type of pasture are those for some grasses of Meteor Downs, Central Queensland. (H. R. Marston, C.S.I.R. Bulletin 61, 1932); these, too, show a high ash figure and a high proportion of silica. The grasses from Turee Creek tend to be quite low in both calcium and phosphorus. The low calcium figures are in marked contrast to high values found in pastures of the wheat belt areas. (1). This difference may possibly be correlated with a difference of the calcium status of the soils of the two areas.

A marked feature of the analyses is the low protein content of many of the samples though there is a definite increase in the protein content of the Weeping, Wind, Mitchell and Crabhole grasses and to a lesser extent of the Kangaroo Grass, during the months of February, March and April of 1934. This is almost certainly due to the growth of young shoots induced by rain that fell during this period.

The high fibre content of the grasses places it on a level with straw rather than pasture herbage with respect to this constituent. The analyses of various straws are given in the following table for comparison; the figures have all been calculated to a moisture free basis:—

Analysis of Straw Samples.

Type.	Source.	Reference.	Moisture.	Crude Protein.	Ether Extract.	Ash.	Crude Fibre.	Nitrogen free Extract.
Oaten ...	Meckering, W.A.	1	7·4	1·5	1·8	3·7	33·0	60·0
Oaten ...	Chapman, W.A.	1	10·7	1·4	2·0	6·6	39·9	50·1
Oaten ...	South Australia*	2	10·3	1·0	0·7	6·6	41·6	50·1
Wheaten	Victoria ...	3	11·0	4·6	1·6	7·1	32·7	54·0
Oaten ...	Victoria ...	3	11·0	2·5	1·8	6·9	34·8	54·0
Barley ...	Victoria ...	3	10·0	3·9	1·7	6·5	40·8	47·1

* Average 13 samples, 1923.

Although the fibre content of the Turee Creek grasses is high, it is considerably lower than that of the grasses from Meteor Downs.

A discussion of the feeding value of the grasses from a consideration of the analyses is not easy owing to a lack of other data. There is the difficulty of knowing how far the sample analysed represents the material actually consumed by the grazing animal. Cattle only are run at Turee Creek; these would be much less selective than sheep in their grazing, but it is probable that they will tend to leave the more fibrous stalks, and so consume a product rather more nutritious than the sample analysed (i.e., the whole plant). No digestibility figures for this type of feed are available but it is probable that, from the high fibre figures, the herbage will be of a low digestibility.

A comparison of the analyses with those of standard feeding stuffs indicates that, of the lower fibre (29-34%) grasses (Mitchell and Crabhole grass), when the protein is low (3-4%), the quality approximates to that of poor quality wheaten hay, but in periods of high protein (9-12%) the grasses will have a much higher feeding value. At the other end of the range, we have wind grass of high fibre content (38-44%); when the protein of this grass is low, the composition is similar to that of oaten straw and would be expected to have a very low feeding value. The samples of higher protein content (6-7%) will have a slightly greater feeding value but even at the best it is probably a very poor feeding stuff. In the North this grass is apparently considered as of very little value as a feed, a conclusion which is strongly supported by the analyses. Between these extremes we have the weeping grass of intermediate fibre content (32-37%) and a variable protein content (2-8%). Flinders grass and Kangaroo grass have similar fibre content but are characterised by very low protein figures (1-4%)—a fact which suggests a very small feeding value with respect to this constituent. Flinders grass, however, is considered a valuable grass and it is not safe to draw any conclusions as to its feeding value from one analysis only. The high fibre and

low protein content of almost all the grasses examined suggests that at least in certain periods of the year the likelihood of a protein deficiency in the grazing is very great.

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LOCAL CROP COMPETITIONS.

I. THOMAS, Superintendent of Wheat Farming.

In addition to the 50-acre crop competitions conducted by the Royal and District Agricultural Societies under the Zone system several separate competitions have been conducted.

The Bruce Rock Agricultural Society and the Koorda Agricultural Society each conducted a Fallow and Crop Competition.

The competition for the Bevan Trophy was continued for another year in the Wialki district under the control of the local branch of the Wheat Growers' Union.

The Kirwan Agricultural Bureau conducted a 50-acre crop competition under the same conditions as govern the Royal Agricultural Society's competition though not affiliated with it.

The particulars of the respective competitions are as follow:—

BRUCE ROCK AGRICULTURAL SOCIETY.

Fallow and Crop Competition.

Judges: A. S. Wild, B.Sc. (Agric.), Agricultural Adviser—Fallow section; W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser—Crop section.

The rainfall recorded at Bruce Rock for 1937 is shown below:—

——	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Bruce Rock	4	9	47	61	228	144	45	231	49	87	729	154	4	1,008

KOORDA AGRICULTURAL SOCIETY.

Fallow and Crop Competition.

Judge: W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser.

The rainfall recorded at Koorda. Booralaming and Cowcowing is shown below.

——	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Koorda	59	7	48	80	215	112	28	232	73	31	691	66	*Nil*	901
Booralaming ...	30	10	12	42	252	187	26	190	58	21	784	76	*Nil*	904
Cowcowing	50	*Nil*	35	28	223	154	33	197	57	27	691	24	*Nil*	828

The judges' awards are shown in the following tables:—

BRUCE ROCK AGRICULTURAL SOCIETY.

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.	Fallow Competition Total.	Total for Fallow and Crop Competition.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.	100 pts.	200 pts.
Pimlott, S. H.	Kwolyin	Totadgin	18	8	9	14	13	62	86	148
Ellis, E. G. & M. P.	Ardath	Bencubbin	19	8	9	12	10	58	85	143
Boase, E. M.	Bruce Rock	Totadgin	15	9	9	14	10	57	85	142
Buller, A. M.	do.	Gluclub	17	7	8	12	10	54	86	140
Fuchsbichler, M.	do.	Bencubbin	11	8	9	12	10	50	86	136

KOORDA AGRICULTURAL SOCIETY

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.	Fallow Competition Total.	Total for Fallow and Crop Competition
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.	100 pts.	200 pts.
Best, R. T.	Booralaming, *via* Dowerin	Bencubbin	17	7	9	14	14	61	79	140
Sharman, H.	do. do.	Totadgin	16	8	9	14	14	61	73	134
Lehmann & Richardson	Dukin	Bencubbin	15	8	9	13	11	56	89	145

THE BEVAN TROPHY.

Judge: W. M. Nunn, B.Sc. (Agric.), Agricultural Adviser.

The competition for this trophy donated by Mr. A. W. Bevan for competition in the Wialki-Bonnie Rock area was this year conducted under the direction of the Wialki branch of the Wheat Growers' Union. Conditions governing the competition were the same as those governing the Royal Agricultural Society's Competitions.

The rainfall recorded at Wialki. North Wialki, Moondon, and South Wialki is shown below.

——	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Wialki	74	14	37	42	155	28	16	216	70	28	513	44	.	824
North Wialki .	80	11	60	34	134	171	22	168	46	26	567	87	5	844
Moondon	60	25	40	20	150	169	14	223	49	22	627	80	.	801
South Wialki	57	15	33	36	89	130	15	190	44	12	480	(not available)		

The judge's awards are set out in the following table:—

Competitor.	Address.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
			50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Miguel, J. A	Wialki	Noongaar	13	9	9	14	14	59
Bratt, H. L.	do.	Bencubbin	14	8	8	14	13	57
Vincent, K. A. M	do	do.	13	8	9	13	13	56
Klie, W	do	do.	12	7	9	14	13	55
Chamberlain, J.	do.	do.	11	8	9	14	13	55
Clark, J. & W. M.	do.	do.	11	8	9	14	13	55
Barwise, P. J.	do.	do.	10	8	9	14	14	55
Matthews, G. H.	do.	do.	11	8	9	13	12	53
Goff, G. (sen.)	do.	do.	11	7	9	12	13	52
Willox, J. G.	do.	Gluyas Early	9	6	9	13	12	49
Styler, F. W.	do.	Bencubbin	10	8	9	10	11	48
Greig, W. W.	do.	Noongaar	8	6	9	12	10	45
Arnold, J. G.	do.	Carrabin	7	6	9	14	8	44

KIRWAN AGRICULTURAL BUREAU.

Judge: R. P. Roberts, B.Sc. (Agric.) Hons., Agricultural Adviser.

Rains recorded at Burakin and at Kokardine are shown below:—

——	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
Burakin ..	54	4	55	36	253	178	36	256	45	28	796	122	*	*
Kokardine	*Nil*	*Nil*	89	50	230	203	38	245	90	28	843	111	3	1,096

* Not available.

The judge's awards are set out in the following table:—

Competitor.	Variety.	Yield.	Freedom from Weeds.	Freedom from Disease.	Freedom from Admixture.	Evenness of Growth.	Total.
		50 pts.	10 pts.	10 pts.	15 pts.	15 pts.	100 pts.
Strahan, E. F.	Bencubbin	24	9	9	12	14	68
Mitchell, H.	do.	23	8	9	13	12	65
Mitchell, J. A.	do.	19	9	9	13	13	63
Joynes, W.	do.	17	8	9	12	13	59
Montague, J.	Totadgin	18	7	9	12	12	58
Joynes, G.	Merredin	19	8	8	11	12	58
Strahan Bros.	Bencubbin	15	8	9	12	13	57
Flavell, R.	do.	17	8	8	10	11	54
Broadhurst, Mrs. H. A.	do.	14	6	9	9	11	49

FIELD EXPERIMENTS WITH WHEAT AND OATS, 1937, AT THE AGRICULTURAL RESEARCH STATIONS.

I. THOMAS,
Superintendent of Wheat Farming.

At each of the Research Stations located in the Wheat Belt, field experiments with wheat and oats are conducted each year. These Research Stations are widely separated and embrace a considerable variation of soil and climatic conditions.

The field experiments conducted cover a wide range and include such important phases as fallowing, depth and time of ploughing and frequency of cultivation. The most prolific varieties, the best time to plant, the most economical rates of seed and superphosphate to apply, and the effect of various fungicides upon the yields are ascertained.

With but one or two minor exceptions the experimental plots are one eighth of an acre in area. They are long and narrow, being one drill width wide, and measure 833 links by 15 links, and are replicated five times.

They are designed on the "three plot" system, the centre plot of each section (three plots) being the control—thus each varying factor is adjacent to a control plot.

The results of the Chapman, Dampawah, Merredin, Salmon Gums and Yilgarn Research Stations are given, but unfortunately the experiments at the Wongan Hills Research Station were destroyed by a very severe hail storm before they were harvested.

MERREDIN RESEARCH STATION.

J. H. Langfield, Farm Manager.

This station is located 160 miles from Perth on the Eastern Goldfields Railway and is approximately in the centre of the main Eastern Wheat Belt. The major portion of the land is salmon gum and gimlet forest country.

The following table shows the monthly rainfalls as recorded at the Station during 1937, together with the average rainfall for the past 26 years:—

Year.	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
1937	25	6	31	31	206	164	37	169	47	28	651	96	6	846
Av., 26 years ...	49	44	101	87	129	176	175	152	82	78	702	39	51	1,163

The first four months were very dry during which period only 94 points of rain fell. This following a very dry year in 1936, when only 881 points were registered, left the subsoil almost depleted of moisture. The seasonal rains commenced on 17th May and conditions for early growth were very favourable, but a prolonged dry spell during July and early August however seriously affected the growth of the crops. Good rains late in August revived them, but owing to a lack of finishing rains the yields obtained did not reach earlier expectations.

The cultural details with the exception of the Fallow *v.* Non Fallow, Time of Ploughing and Mulching Experiments were as follow:—

The land on which the plots were planted was ploughed in early July, 1936, with a disc plough to a depth of 3½-4 ins. It was cultivated with a rigid tyne scarifier in September, 1936, and again with the tandem disc harrows just prior to seeding.

FALLOW V. NON-FALLOW.

The object of this experiment is to ascertain the effect of fallowing upon the grain yield of the subsequent wheat crop.

The fallowed plots were ploughed 3-4 inches deep in mid June, 1936, with a disc plough, scarified in August, 1936, and cultivated with a disc cultivator prior to seeding, whilst the non-fallowed plots were ploughed 27th May, 1937, with a disc plough and cultivated with a disc cultivator before seeding.

FALLOW v NON-FALLOW EXPERIMENT.

Planted on 2nd June, 1937. Superphosphate—112lbs. per acre.
Germinated on 16th June, 1937. Variety—Noongaar. Seed—45lbs. per acre.

Treatment.	Average Yields per acre. bus. lb. 1937.		Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1925–37.		Percentage Yields. % 1925–37.
Non-fallow	12	8	100	15	44	100
Fallow	16	32	136	21	52	139

The results for this and previous years show the definite advantage to be obtained from planting the wheat crop on fallowed land.

TIME OF PLOUGHING EXPERIMENT.

The object of this experiment is to ascertain whether the time of carrying out the initial operation of fallowing, i.e. ploughing, has any effect upon the yield of the resulting wheat crop.

The land for this experiment was ploughed in three sections during 1936; one in March, another in June (the control) and the third in August. Each section was cultivated with a rigid tyne scarifier in September, 1936, and prior to seeding with the tandem disc harrows.

TIME OF PLOUGHING EXPERIMENT.

Planted on 2nd June, 1937. Superphosphate—112lbs. per acre.
Germinated on 16th June, 1937. Variety—Noongaar. Seed—45lbs. per acre.

Treatment. (Ploughed 1936.)	Average Yields per acre. bus. lb. 1937.		Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1930–37.		Percentage Yields. % 1930–37.
Mid-July	15	4	92	25	20	93
Mid-June	16	24	100	27	4	100
Mid-August	15	28	94	21	12	78

The results for 1937 and the average for those of the previous years show that higher yields are obtained when the land is fallowed in the early winter months rather than in the late winter or early spring.

MULCHING EXPERIMENT.

The object of this experiment, which has been conducted since 1915, is to determine to what extent and under what conditions the cultivation of winter fallowed land is profitable during the spring and summer.

To meet the requirements of the experiment three plots were treated, as follows:—

Plot 1.—Cultivated prior to seeding only (neglected fallow).

Plot 2.—Cultivated during spring and prior to seeding (ordinary fallow).

Plot 3.—Cultivated during spring, again when required during summer after 25 points of rain or over, and again prior to seeding.

Plot No. 1 was cultivated with tandem disc harrows prior to seeding only.

Plot No. 2 was cultivated on 21st September, 1936, with a springtyne implement and prior to seeding using a tandem disc.

Plot No. 3 was cultivated on 21st September, 1936, and the 27th December, 1936, with a springtyne cultivator and again prior to seeding using a tandem disc harrow.

All plots were ploughed in July, 1936.

MULCHING EXPERIMENT, 1937.

Planted on 12th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 24th May, 1937. Variety—Totadgin. Seed—45lbs. per acre.

Treatment.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1915–37.*	Percentage Yields. % 1915–37.*
Mulched before planting only ...	16 24	103	20 0	95
Mulched in spring and before planting	15 52	100	21 4	100
Mulched in spring, after rain during summer, and before planting	16 0	101	21 28	102

* 1936 excluded.

This year's results and the results of the previous years indicate that payable increases in yield do not result from summer cultivation. However in some years special circumstances, such as the setting of the soil after excessive rain and heavy weed growth which cannot be controlled by stock, necessitate these cultivations.

TIME OF PLANTING EXPERIMENT.

The object of this experiment is to determine the most suitable month to plant the wheat crop.

To meet the requirements of this experiment the midseason maturing variety Nabawa was planted in mid April, May and June, while Gluyas Early, an early maturing variety, was sown in mid May, June and July.

TIME OF PLANTING EXPERIMENT, 1937.

Superphosphate—112lbs. per acre. Variety—Nabawa. Seed—45lbs. per acre.

Date planted.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.*	Percentage Yields. % 1929–37.*
15th April	10 48	111	22 0	107
15th May	9 44	100	20 32	100
15th June	6 16	64	16 16	79

* 1936 excluded.

TIME OF PLANTING EXPERIMENT, 1937.

Superphosphate—112lbs. per acre. Variety—Gluyas Early. Seed—45lbs. per acre.

Date planted.	Average Yields per acre. bu. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1923–37.*	Percentage Yields. % 1923–37.*
15th June	9 4	80	21 4	92
15th May	11 20	100	22 56	100
15th July	2 48	25	12 40	55

* 1936 excluded.

These results and experience elsewhere in the Eastern Wheat Belt indicate that the planting of a midseason variety should in general not extend beyond the middle of May, and the early variety after the end of May.

RATE OF SEEDING EXPERIMENT.

The object of this experiment is to determine the most economical rate of seed with:—

(a) A mid-season free-stooling variety;

(b) An early sparse-stooling variety.

To meet these requirements, the variety Nabawa was used in the first case, and the variety Noongaar in the second, and each was sown at the rate of 30, 45 and 60 lbs. of seed per acre.

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 7th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 24th May, 1937. Variety—Nabawa.

Rate of Seed per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1913–37.	Percentage Yields. % 1913–37.
30lbs.	15 12	98	18 40	94
45lbs.	15 28	100	19 52	100
60lbs.	14 40	95	19 52	100

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 1st June, 1937. Superphosphate—112lbs. per acre.
Germinated on 16th June, 1937. Variety—Noongaar.

Rate of Seed per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1915–37.	Percentage Yields. % 1915–37.
30lbs.	13 36	97	18 8	96
45lbs.	14 0	100	18 56	100
60lbs.	14 0	100	18 56	100

The results for both sections show that there is no advantage in sowing more than 45 lbs. of seed per acre.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT.

The object of this experiment is to ascertain the most profitable rate of superphosphate to apply to the wheat crop.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT, 1937.

No. 1.

Planted on 11th May, 1937. Germinated on 25th May, 1937. Variety—Totadgin.
Seed—45 lbs. per acre.

Rate of Application of Superphosphate per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.*	Percentage Yields. % 1929–37.*
Nil	8 24	59	13 4	57
150lbs.	14 16	100	22 48	100
75lbs.	14 0	98	20 48	91

* 1936 excluded.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT, 1937.
No. 2.

Planted on 11th May, 1937. Germinated on 25th May, 1937. Variety—Totadgin. Seed—45lbs. per acre.

Rate of Application of Superphosphate per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1929–37.*	Percentage Yields. % 1929–37.*
300lbs.	15 52	97	24 24	105
150lbs.	16 24	100	23 20	100
225lbs.	15 44	96	24 8	103

* 1936 excluded.

This year's results and the averages for the past seven years indicate that the rate of superphosphate can be increased with advantage above 75 lbs. per acre. The most economical rate on this class of soil under present conditions would be about 90-100 lbs. per acre.

POTASH-NITROGEN EXPERIMENT.

The object of this experiment is to determine the effect upon the wheat crop of the application of—

(a) A nitrogenous fertiliser;

(b) A nitrogenous plus a potassic fertiliser.

Sulphate of ammonia, a nitrogenous fertiliser, and sulphate of potash, a potassic fertiliser, were used in addition to superphosphate.

The results obtained are given below:—

POTASH-NITROGEN EXPERIMENT, 1937.

Planted on 25th May, 1937. Germinated on 4th June, 1937. Variety—Totadgin. Seed—45lbs. per acre.

Rate of Fertiliser per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.	Percentage Yields. % 1932–37.
1 cwt. Superphosphate; 1 cwt. Sulphate of Ammonia	14 0	100	20 8	102
1 cwt. Superphosphate	14 0	100	19 44	100
1 cwt. Superphosphate; 1 cwt. Sulphate of Ammonia; 1 cwt. Sulphate of Potash	13 44	98	19 52	101

The results for this and previous years show that the application of a potassic or nitrogenous fertiliser in addition to superphosphate leads to no increase in yields.

SEASONAL PLANTING EXPERIMENT.

The objects of this experiment are:—

(a) To ascertain the most suitable month to plant the late, mid-season, early, and very early maturing varieties of wheat; and

(b) To determine the most prolific of each of the above types.

To meet the requirements of the experiments three sections were needed, viz.—

(a) Section 1, planted in April—Representing early planting.

(b) Section 2, planted in May—Representing mid-season planting.

(c) Section 3, planted in June—Representing late planting.

In all sections the standard mid-season maturing variety Nabawa was planted in the control plots.

SEASONAL PLANTING EXPERIMENT, 1937.

April Planting.

Planted on 15th April, 1937. Superphosphate—112lbs. per acre.
Germinated on 24th May, 1937. Seed—45lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb.	Percentage Yields. % 1929–37.*
Bencubbin	10 24	113	...	112
Nabawa	9 12	100	...	100
Totadgin	10 24	113	...	93†

* 1936 excluded. † 1930–31–37.

SEASONAL PLANTING EXPERIMENT, 1937.

May Planting.

Planted on 15th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd June, 1937. Seed—45lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb.	Percentage Yields. %
Bencubbin	9 28	118	...	112*
Nabawa	8 0	100	...	100*
M 44	7 12	92	...	...†
Gluyas Early	9 44	122	...	109‡
Nabawa	8 0	100	...	100†
M 58	10 0	125	...	...†
Totadgin	8 48	114	...	118§
Nabawa	7 44	100	...	100§
M 45	7 28	97	...	...†
M 47	6 56	96	...	...†
Nabawa	7 12	100	...	100†
M 51	7 20	102	...	...†
M 52	8 0	113	...	...†
Nabawa	7 4	100	...	100†
M 53	7 44	109	...	...†
M 54	7 44	108	...	...†
Nabawa	7 12	100	...	100‡
Noongaar	8 8	113	...	102‡

* 1929–37 with 1936 excluded. † 1937 only. ‡ 1928–37 with 1936 excluded.
§ 1931–37 with 1936 excluded.

SEASONAL PLANTING EXPERIMENT, 1937.

June Planting.

Planted on 15th June, 1937. Superphosphate—112lbs. per acre.
Germinated on 2nd July, 1937. Seed—45lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs.	Percentage Yields. %
Bencubbin	3 28	108	...	112†
Nabawa	3 12	100	...	100†
M 58	6 32	204	...	...§
Gluyas Early	5 36	183	...	112*
Nabawa	3 4	100	...	100*
Totadgin	5 28	178	...	119‡
Geeralying	4 48	120	...	99*
Nabawa	4 0	100	...	100*
Noongaar	6 48	170	...	118*

* 1928–37 with 1936 excluded. † 1930–37 with 1936 excluded. ‡ 1931–37 with 1936 excluded. § 1937 only.

In the April section this year the varieties Bencubbin and Totadgin gave similar yields. The average results, however, show that the mid-season maturing variety Bencubbin is the most suitable for planting in April.

In the section planted in May, M.58, Gluyas Early, Bencubbin, Totadgin, M.52 and Noongaar yielded well. In the average results the varieties Totadgin, Bencubbin and Gluyas Early have proved most suitable for planting in May.

The yields of the whole of the June section are very low, owing to late germination and the adverse season, and show that the yields are very considerably reduced by planting in June. The new crossbred M.58 was outstanding in the June section and also gave the highest yield in the May section.

OAT VARIETY TRIALS.

The object of this experiment is to ascertain the grain yielding capacity of several varieties of oats.

The varieties under test were Mulga, Guyra and Wongan. The latter is a new crossbred (Burt's Early x Mulga) which was produced at the Wongan Hills Research Station. This variety is approximately a week earlier, and is shorter in the straw than either of its parents.

OAT VARIETY TRIAL.

Planted on 3rd May, 1937. Superphosphate—112lbs. per acre.
Germinated on 28th May, 1937. Seed—40lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb.	Percentage Yields. % 1931–37.*
Mulga	18 32	100	...	100
Guyra	19 32	105	...	98
Wongan	18 32	96	...	...
Mulga	19 24	100	..	100

* Excluding 1935 and 1936.

There is no significant difference between the yields of the different varieties. The yields however, in view of the adverse growing season, can be considered satisfactory, and indicate the suitability of the varieties for districts of low rainfall.

FUNGICIDE EXPERIMENT.

The object of this experiment is to determine the effect upon the germination, growth and grain yields of a finely powdered organic mercury compound and copper carbonate, when used as a fungicide for wheat and oats.

Plots were sown with seed treated with an organic mercury compound and with Copper Carbonate, at the rate of two ounces per bushel and compared with control plots of untreated seed. No difference could be noticed regarding germination and growth during the year. The results obtained are as follow:—

FUNGICIDE EXPERIMENT, 1937.

WHEAT.

Planted on 8th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 24th May, 1937. Variety—Totadgin. Seed—45lbs. per acre.

Treated with—	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb.	Percentage Yields. %
A Mercury Compound	5 4	109	...	..
Untreated	4 40	100	...	.
Copper Carbonate	4 56	106	...	

FUNGICIDE EXPERIMENT, 1937.

OATS.

Planted on 8th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 24th May, 1937. Variety—Mulga. Seed—36lbs. per acre.

Treated with—	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb.	Percentage Yields. %
A Mercury Compound	11 24	89	...	...
Untreated	13 0	100	...	...
Copper Carbonate	12 8	94	...	...

This is the second year that the experiment has been conducted. The results in 1936, however, were affected by drought conditions. In 1937 slight increases were obtained from the use of each of the fungicides for wheat. With the oats there was a decrease in yield.

The results are for one year only and further results are necessary before definite conclusions may be drawn.

CHAPMAN RESEARCH STATION.

F. GISHUBL,
Farm Manager.

The Chapman Research Station is situated on the Upper Chapman River, 28 miles north of Geraldton and 334 miles by rail from Perth. The land on the station is mostly typical jam timber country with a little York gum running into lighter timbered country.

The following table shows the monthly rainfall as recorded at the Station during 1937, and the average rainfall for the past 32 years—

Year.	Jan.	Feb.	Mar.	Apl.	Growing Period.— May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
1937	4	17	2	84	333	539	37	306	156	46	1,417	26	11	1,561
Av., 32 years	28	40	75	67	240	425	378	280	156	93	1,572	31	24	1,837

Owing to the good May rains the crop was planted in a moist seed bed and made good growth until checked by the dry spell experienced in July. Only 37 points fell between 28th June and 6th August, during which period eleven frosts and frequent hot, drying winds were experienced. However, good rains fell during the remainder of August and September and the crops made a very good recovery.

The land on which the experiments were planted originally carried York gum, jam and wattle. It has been under cultivation for many years. After several years grazing it was fallowed in 1934, cropped 1935 and fallowed again in 1936.

With the exception of the Fallow *v.* Non-Fallow experiment, the cultural details of the experiments are as follow:—

The land was ploughed with a mouldboard plough to a depth of 4 inches in June-July, 1936, cultivated with a springtyne cultivator in early September, 1936, early May, 1937, and prior to seeding which was done with a disc drill. The land at the time of seeding was clean and in good condition.

FALLOW V. NON-FALLOW EXPERIMENT.

The object of this experiment is to ascertain the effect of fallowing upon the subsequent wheat crop.

The fallowed plots were ploughed in July, 1936, with a mouldboard plough and springtyne cultivated in September, 1936, March, 1937, and twice in May,

1937, whilst the non-fallowed plots were ploughed in May, 1937, with a mouldboard plough and springtyne cultivated and seeded the following day.

The results are as follow:—

FALLOW *v.* NON-FALLOW EXPERIMENT.

Planted on 26th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 30th May, 1937. Variety—Nabawa. Seed—60lbs. per acre.

Treatment.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.	Percentage Yields. % 1929–37.
Fallow	24 24	161	16 24	124
Non-fallow	15 12	100	13 12	100

The fallowed plots withstood the dry spell in July much better than the non-fallowed and at maturity they were 6-8 inches higher and denser. Although not entirely free from weeds the fallowed plots had far less weed competition than the non-fallowed plots, which suffered badly, due to doublegees and other weeds coming away at the same time as the wheat.

The results for this and previous years are distinctly in favour of fallowing for wheatgrowing.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT.

The object of this experiment is to ascertain the most economical rate of superphosphate to apply to the wheat crop.

The results are tabulated below:—

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT, 1937.

Planted on 21st May, 1937. Germinated on 28th May, 1937. Variety—Nabawa. Seed—60lbs. per acre.

Rate of Application of Superphosphate per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.	Percentage Yields. % 1929–37.
Nil	11 36	91	10 56	80
150lbs.	12 48	100	13 36	100
75lbs.	12 32	98	12 32	92

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT, 1937.

Planted on 21st May, 1937. Germinated on 28th May, 1937. Variety—Nabawa. Seed—60 lbs. per acre.

Rate of Application of Superphosphate per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1929–37.	Percentage Yields. % 1929–37.
300lbs.	13 28	113	13 52	106
150lbs.	11 52	100	13 4	100
225lbs.	13 32	105	13 20	102

This year's results and those of the previous eight years indicate that the rate of superphosphate can be increased with advantage above 75 lbs. per acre and that the most economical rate under present conditions is approximately 100 lbs. per acre.

POTASH-NITROGEN EXPERIMENT.

The object of this experiment is to determine the effect upon the grain yield of the subsequent wheat crop of the application of:—

(a) A nitrogenous fertiliser.

(b) A nitrogenous fertiliser plus a potassic fertiliser.

In addition to the usual application of superphosphate, sulphate of ammonia, a nitrogenous fertiliser, and sulphate of potash, a potassic fertiliser, were used.

The results are as follow:—

NITROGEN-POTASH EXPERIMENT, 1937.

Planted on 24th May, 1937. Germinated on 29th May, 1937. Variety—Nabawa. Seed—60 lbs. per acre.

Rate of Application of Fertiliser per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.	Percentage Yields. % 1932–37.
1 cwt. Superphosphate; 1 cwt. Sulphate of Ammonia	26 48	103	15 28	106
1 cwt. Superphosphate	26 0	100	14 32	100
1 cwt. Superphosphate; 1 cwt. Sulphate of Ammonia; 56 lbs. Sulphate of Potash	26 40	103	15 44	108

The results show that slight increases in yields are obtained by the application of a nitrogenous fertiliser (in addition to superphosphate) but no further increase results from the use of a potassic fertiliser in addition. The increases are not sufficient to warrant the expenditure incurred. It is felt that the nitrogen level and the general fertility of these soils could be materially improved by pasture improvement, utilising leguminous crops such as lupins, first early subterranean clover, etc., during the grazing years.

RATE OF SEEDING EXPERIMENT.

The object of this experiment is to determine the most economic rate of seeding for:—

(a) A mid-season, free stooling variety;

(b) An early, sparse stooling variety.

The variety Nabawa was used in the former case, whilst S.H.J. was used in the latter.

The results are as follow:—

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 22nd May, 1937. Superphosphate—112lbs. per acre.
Germinated on 28th May, 1937. Variety—Nabawa.

Rate of Seed per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1923–37.*	Percentage Yields. % 1923–37.*
45lbs.	24 16	100	14 32	100
60lbs.	24 24	101	14 56	103
90lbs.	25 28	105	15 52	109

* 1932 excluded.

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 22nd May, 1937. Superphosphate—112lbs. per acre.
Germinated on 28th May, 1937. Variety—S.H.J.

Rate of Seed per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1923–37.	Percentage Yields. % 1923–37.*
60lbs.	15 12	109	16 16	107
45lbs.	14 0	100	15 12	100
90lbs.	17 36	126	16 56	111

* 1932 excluded.

Both this year's and average results for the period of the experiment are in favour of the heavier rates of seeding, particularly with the early or sparse stooling variety. Where competition from weeds is likely to occur, 60 lbs. for the mid-season variety and probably higher for the early maturing variety could be used with advantage.

FUNGICIDE EXPERIMENT.

The object of this experiment is to determine the effect upon the germination, growth and grain yield of a finely powdered organic mercury compound and copper carbonate when used as fungicides for wheat.

FUNGICIDE EXPERIMENT, 1937.

Planted on 22nd May, 1937. Superphosphate—112lbs. per acre.
Germinated on 28th May, 1937. Variety—Nabawa. Seed—60lbs. per acre.

Seed Pickled with—	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1936–37.	Percentage Yields. % 1936–37.
A Mercury Compound	18 48	105	16 32	103
No treatment	17 52	100	16 0	100
Copper Carbonate	19 12	107	16 40	104

The results for 1937 and the average results for the two years the experiment has been conducted indicate that slight increases in yield are obtained from the use of these fungicides, although no difference could be detected either in the germination or growth of the treated plots. Further experiments will be necessary before definite conclusions may be drawn.

YILGARN RESEARCH STATION.

W. A. HUMAN,
Farm Manager.

The Yilgarn Research Station is situated on the eastern fringe of our present defined wheat-growing area. This station which is adjacent to Ghooli siding, eight miles east of Southern Cross, on the Eastern Goldfields railway, was established in December, 1926, and was officially opened in May, 1928.

The following table shows the monthly rainfalls as recorded at the station during 1937, together with the average rainfall for the past nine years:—

Year.	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year
1937	32	6	293	48	73	138	43	143	35	30	462	141	14	996
Av., 9 years, 1928–36	48	45	68	107	144	137	128	153	50	75	687	54	51	1,060

The rainfall for the growing period, 462 points, was the lowest on record. There was a general absence of good soaking rains throughout this period. A fall of 210 points in March materially assisted to carry the crop through the prolonged dry spell experienced during July and early August.

The land on which these experiments were conducted was originally timbered with salmon gum and gimlet, and was previously cropped in 1935.

Excepting where the requirements of an experiment required other working, the cultural details of all experiments were as follow:—

The plots were ploughed with a disc-cultivating plough to a depth of 3-4 inches in July, 1936, cultivated with a rigid tyne cultivator in August, 1936, and spring-tyne cultivated in March, 1937, after heavy rain, and again prior to seeding. The seed was sown on a moist seed bed.

TIME OF PLOUGHING EXPERIMENT.

The object of this experiment is to ascertain whether the time of carrying out the initial operation of fallowing, *i.e.*, ploughing, has any effect upon the yield of the resulting wheat crop.

The land for this experiment was ploughed in three sections during 1936; one was ploughed in March, another in June (the control), and the third in August. Each section was cultivated in August, 1936, with a rigid tyne cultivator, during March, 1937, after a heavy rain and prior to seeding, with a spring-tyne implement. The March-ploughed plots produced greater weed growth in the following autumn. At the time of planting all the plots were in good condition.

TIME OF PLOUGHING EXPERIMENT, 1937.

Planted on 24th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd July, 1937. Variety—Gluyas Early. Seed—40lbs. per acre.

Time of Ploughing.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1929–37.*	Percentage Yields. % 1929–37.*
March	9 4	105	10 32	93
June	8 40	100	11 20	100
August	10 8	117	10 56	96

* 1930, 1931, 1932 and 1936 excluded.

The average results from this experiment for the years in which it has been conducted show that the initial operation of fallowing is best carried out during the early winter.

DEPTH OF PLOUGHING EXPERIMENT.

The object of this experiment is to determine the most economical depth to plough when fallowing for the wheat crop.

DEPTH OF PLOUGHING EXPERIMENT, 1937.

Planted on 24th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd July, 1937. Variety—Gluyas Early. Seed—40lbs. per acre.

Depth of Ploughing.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1933–37.*	Percentage Yields. % 1933–37.*
2in.	10 8	106	11 52	100
4in.	9 36	100	11 52	100
6in.	10 8	100	11 52	100

* 1934 and 1936 excluded.

This year's results show a slight but insignificant increase in yield for the 2in. deep section, but the average results for the period of the experiment (1933-37) show no difference between any of the sections. However, it is found that the plots ploughed to a depth of 2 inches require additional cultivation to maintain the mulch and provide a satisfactory seed-bed and, in view of this, it is more economical to plough to a depth of 4 inches.

MULCHING EXPERIMENT.

The object of this experiment is to determine to what extent and under what conditions the cultivation of winter fallowed land is profitable during the spring and summer.

To meet the requirements of the experiment, three plots were treated, as follows:—

Plot 1.—Cultivated prior to seeding only (neglected fallow).

Plot 2.—Cultivated during spring and prior to seeding (ordinary fallow).

Plot 3.—Cultivated during spring, again when required during summer after 25 points of rain or over, and again prior to seeding.

All plots were ploughed in July, 1936.

Plot 1 was spring-tyne cultivated in August, 1936, November, 1936, and December, 1936, March, 1937, and prior to seeding.

Plot 2 was cultivated in August, 1937, and prior to seeding.

MULCHING EXPERIMENT, 1937.

Planted on 25th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd July, 1937. Variety—Gluyas Early. Seed—40lbs. per acre.

When Cultivated.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1928–37.*	Percentage Yields. % 1928–37.*
Before seeding only	8 56	103	11 44	98
In spring and before seeding ...	8 40	100	12 0	100
In spring, after summer rains, and before seeding	9 12	106	12 32	104

* 1936 excluded.

This year's results and the average results for nine years indicate that while slight increases in yield may result from spring and summer cultivation, these increases are not economical.

TIME OF PLANTING EXPERIMENT.

The object of this experiment is to determine the most suitable month to plant the wheat crop.

To meet the requirement of this experiment, two varieties of different maturity were used, Nabawa representing the mid-season varieties and Gluyas Early the early-maturing varieties.

TIME OF PLANTING EXPERIMENT, 1937.

Superphosphate—112lbs. per acre. Variety—Nabawa. Seed—40lbs. per acre.

Date Planted.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.*	Percentage Yields. % 1929–37.*
April 17th	10 40	154	17 28	106
May 18th	6 56	100	16 32	100
June 16th	7 36	110	10 32	63

* 1936 excluded.

TIME OF PLANTING EXPERIMENT, 1937.

Planted on 18th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd July, 1937. Variety—Gluyas Early. Seed—40lbs. per acre.

Date Planted.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1929–37.*	Percentage Yields. % 1929–37.*
May 18th	9 4	100	17 4	100
June 16th	9 44	107	12 32	73
July 15th	Destroyed by grasshoppers.			

* 1936 excluded.

The May and June plantings in both the Nabawa and Gluyas Early germinated practically together on 3rd July, and hence the results this year are of little value. The average results, however, indicate that the best returns are obtained by planting the mid-season variety Nabawa during the last two weeks in April and the early variety, Gluyas Early, early in May. Yields are considerably reduced if planting is extended into June. During the last three years the July seeding has been destroyed by grasshoppers and indicates that July seeding is definitely unsuitable.

RATE OF SEEDING EXPERIMENT.

The object of this experiment is to determine the most economic rate of seeding with—

(a) a mid-season, free-stooling variety;
(b) an early, sparse-stooling variety.

To meet these requirements, the variety Nabawa in the former and the variety Noongaar in the latter were used, and each was sown at the rate of 30, 45 and 60 lbs. of seed per acre.

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 17th April, 1937. Superphosphate—112lbs. per acre.
Germinated on 26th April, 1937. Variety—Nabawa.

Rate of Seed per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. *	Percentage Yields. % *
30lbs.	6 32	92	...	...
45lbs.	7 4	100	...	...
60lbs.	6 56	98	...	...

*Average not available as this is first year of rates of seeding 30, 45 and 60 lbs. per acre.

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 27th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd July, 1937. Variety—Noongaar.

Rate of Seed per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. *	Percentage Yields. % *
30lbs.	6 40	98	...	...
45lbs.	6 48	100	...	...
60lbs.	6 48	100	...	...

*Average not available as this is first year of rates of seeding 30, 45 and 60 lbs. per acre.

Previous to this season the rate of seeding in this experiment were 20, 30 and 40 lbs. per acre. Over a period of years the rate of 20 lbs. proved to be too light; therefore it was decided to alter the rates to 30, 45 and 60 lbs. per acre.

In the results this year there is practically no difference in the yields from the different rates of seeding, with either the varieties Nabawa or Noongaar. The average results in the past indicate that for both the free and sparse stooling varieties up to 40 lbs. of seed can be sown to advantage.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT.

The object of this experiment is to ascertain the most profitable rate of superphosphate to apply to the wheat crop.

The results obtained are as follows:—

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT, 1937.

No. 1

Planted on 21st May, 1937. Germinated on 3rd July, 1937. Seed—40lbs. per acre. Variety—Gluyas Early.

Rate of Application of Superphosphate per Acre.	Average Yields per acre. bus. lb. 1937.		Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.*		Percentage Yields. % 1929–37.*
Nil	4	40	44	9	36	55
150lbs.	10	40	100	17	20	100
75lbs.	7	52	74	14	24	83

* 1936 excluded.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT, 1937.

No 2

Planted on 21st May, 1937. Germinated on 3rd July, 1937. Seed—40lbs. per acre. Variety—Gluyas Early.

Rate of Application of Superphosphate per Acre.	Average Yields per acre. bus. lb. 1937.		Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1929–37.*		Percentage Yields. % 1929–37.*
225lbs.	10	48	109	15	52	102
150lbs.	9	52	100	15	36	100
300lbs.	10	32	107	16	0	103

* 1932 and 1936 excluded.

This year's results, and those for the previous years, indicate that increased yields are obtained by applications of superphosphate up to 300 lbs. per acre. The economical rate, however, would be in the vicinity of 100 lbs. per acre.

POTASH-NITROGEN EXPERIMENT.

The object of this experiment is to determine the effect upon the yield of the wheat crop of the application of—

(a) a nitrogenous fertiliser;

(b) a nitrogenous plus a potassic fertiliser.

To meet the requirements of this experiment, sulphate of ammonia, a nitrogenous fertiliser, and sulphate of potash, a potassic fertiliser, were used in addition to superphosphate

POTASH-NITROGEN EXPERIMENT, 1937.

Planted on 21st May, 1937. Germinated on 3rd July, 1937. Seed—40lbs. per acre. Variety—Gluyas Early.

Treatment.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1933–37.*	Percentage Yields. % 1933–37.*
1 cwt. Superphosphate; 1 cwt. Sulphate of Ammonia	7 52	97	14 0	98
1 cwt. Superphosphate	8 8	100	14 16	100
1 cwt. Superphosphate; 1 cwt. Sulphate of Ammonia; 56lbs. Muriate of Potash	7 44	95	13 52	97

* 1936 excluded.

The results for 1937 are in agreement with the results of previous years, in demonstrating that increased yields cannot be expected following the application of a nitrogenous or a nitrogenous plus a potassic fertiliser in addition to superphosphate.

SEASONAL PLANTING EXPERIMENT.

The objects of this experiment are:—

(a) To ascertain the most suitable month to plant the late, mid-season, early and very early maturing varieties of wheat; and

(b) To determine the most prolific of each of the above types.

To meet the requirements of the experiments, three sections were needed, viz.:—

(a) Section 1, planted in April, representing early planting.

(b) Section 2, planted in May, representing mid-season planting.

(c) Section 3, planted in June, representing late planting.

In all sections the standard mid-season maturing variety Nabawa was planted in the control plots.

SEASONAL PLANTING EXPERIMENT, 1937.

APRIL PLANTING.

Planted on 16th April, 1937. Superphosphate—112lbs. per acre.
Germinated on 26th April 1937. Seed—40lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.*	Percentage Yields. % 1932–37.*
Noongaar	6 32	55	10 56	70
Gluyas Early	11 52	100	15 36	100
Totadgin	10 24	88	15 52	102
Bencubbin	14 32	122	17 20	112
Gluyas Early	11 52	100	15 28	100
Nabawa	12 32	106	16 0	103

* 1936 included.

SEASONAL PLANTING EXPERIMENT, 1937.

MAY PLANTING.

Planted on 17th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd July, 1937. Seed—40lbs per acre

Variety.	Average Yields per acre. bus. lb. 1937.		Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.*		Percentage Yields. % 1932–37.*
Noongaar	10	40	93	13	36	84
Gluyas Early	11	28	100	16	16	100
Geeralying	10	8	88	13	52	85
Merredin	11	28	101	15	44	98
Gluyas Early	11	20	100	16	8	100
Totadgin	10	24	92	16	40	103
S.H.J.	10	32	90	13	36	84
Gluyas Early	11	44	100	16	8	100
Carrabin	9	36	82	14	32	90
Bencubbin	12	8	105	17	36	112
Gluyas Early	11	36	100	15	44	100
Nabawa	10	40	92	15	44	100

* 1936 excluded.

SEASONAL PLANTING EXPERIMENT, 1937.

JUNE PLANTING.

Planted on 15th June, 1937. Superphosphate—112lbs. per acre.
Germinated on 3rd July, 1937. Seed—40lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.		Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.*		Percentage Yields. % 1932–37.*
Noongaar	6	8	85	11	36	100
Gluyas Early	7	12	100	11	36	100
Geeralying	4	56	69	9	52	85
Merredin	5	20	71	10	56	95
Gluyas Early	7	28	100	11	28	100
Totadgin	7	28	100	12	16	107
S.H.J.	5	36	72	9	20	77
Gluyas Early	7	44	100	12	8	100
Carrabin	5	28	71	10	16	85
Bencubbin	6	48	91	13	20	111
Gluyas Early	7	28	100	12	0	100
Nabawa	5	36	75	11	44	98

* 1936 excluded.

In the April section the mid-season variety Bencubbin has given the best results both in 1937 and in the previous four years. The original growth of "Noongaar," a very early maturing variety, was destroyed by frost, and the yield obtained was produced by a second growth.

The May and June sections germinated together on 3rd July, and in consequence there is no significant difference in the results for 1937. The average results for the previous four years indicate that the variety Bencubbin is the most suitable one for April sowing and that Bencubbin, Totadgin, Gluyas Early and Noongaar are most suitable for sowing in that order of planting in May. The yields are considerably decreased by drought conditions where planting is carried out in June, and consequently the only conclusion which can be drawn from this section is that sowing should not be continued into this month in these areas.

FUNGICIDE EXPERIMENT.

The object of this experiment is to determine the effect upon the germination, growth and grain yield of a finely powdered organic mercury compound and copper carbonate when used as a fungicide for wheat.

FUNGICIDE EXPERIMENT, 1937.

Planted on 15th May, 1937. Superphosphate—112lbs. per acre.
Germinated on 24th May, 1937. Variety—Totadgin. Seed—40lbs. per acre.

Treated with—	Average Yields per acre.	Percentage Yields.	Average Yields per acre.	Percentage Yields.
	bus. lb.	%	bus. lb.	%
	1937.	1937.		
A Mercury Compound	9 28	99	...	...
Untreated	9 36	100	...	...
Copper Carbonate	9 28	99	...	...

The results in 1936 were discarded owing to seasonal conditions. In 1937 no difference could be observed regarding germination and growth, and there was no significant difference in the yield of the treated and untreated plots. Further trials will be necessary before definite conclusions may be drawn.

DAMPAWAH RESEARCH STATION.

F. A. NEWMAN,
Farm Manager.

The Dampawah Research Station is situated on the southern fringe of the Lower Murchison and the eastern edge of the northern wheat belt, and is approximately 30 miles east of Perenjori. The soil is a red friable loam, uniform in appearance, and was originally timbered with York gum, giant mallee, karara and mulga scrub.

The following table shows the monthly rainfalls as recorded at the station during 1937, together with the average rainfall for the past seven years:—

Year.	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
1937	66	27	24	61	134	333	8	129	37	27	668	27	....	873
Av., 1929–36 ..	63	51	122	72	151	224	157	163	55	40	790	65	40	1,203

The season opened on 14th May, when 35 points of rain fell in two days. This was followed by a further 89 points in two falls two days later. From that time until 8th June no further rain fell. All crops sown up till 20th May germinated evenly. The rainfall for June was extremely good, 333 points being registered in seven falls. Although many frosts, followed by warm days, were then experienced, the crops made good growth up till the middle of July, when 8 points fell, the only rain registered during that month. From then onwards, however, until the end of the third week in August, conditions were very unfavourable and the crops failed to make any growth owing to the cold, dry conditions.

The prolonged dry spell which had lasted nearly eight weeks was relieved by a fall of 22 points of rain on 18th August. From then on until the end of the month further rains fell totalling 129 points. These extremely useful rains materially improved the outlook. Only 37 points fell in September and 27 in October and were of little benefit.

The land on which the experiments were conducted was originally timbered with York gum, giant mallee, mulga, and karara scrub, and was cleared in 1927. It was first cropped in 1929 on fallow and then grazed in 1930, fallowed in 1931, cropped 1932, grazed 1933, fallowed 1934, cropped 1935, fallowed 1936 and cropped again this year.

Excepting where the requirements of the experiments demanded otherwise, the cultural details of the experiments were as follows:—Ploughed with a disc cultivating plough in late June, 1936, cultivated in September, 1936, with a spring-tyne cultivator, and owing to the absence of weeds received no further cultivation. All the plots were sown with a combined cultivator drill.

FALLOW v. NON-FALLOW EXPERIMENT.

The object of this experiment is to ascertain the effect of winter fallowing on the subsequent wheat crop.

The fallowed plots were ploughed in late June, 1936, with a disc cultivating plough to a depth of 3-4 inches and spring-tyne cultivated in September, 1936.

The non-fallowed plots were ploughed in a dry condition in early April, 1937, with a disc cultivating plough. The results obtained are as follows:—

FALLOW v. NON-FALLOW EXPERIMENT, 1937.

Planted on 3rd May, 1937. Superphosphate—90lbs. per acre.
Germinated on 18th May, 1937. Variety—Gluyas Early. Seed—45lbs. per acre.

Treatment.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1930–37.*	Percentage Yields. % 1930–37.*
Fallow	14 32	107	15 4	118
Non-fallow	13 36	100	12 48	100

* 1936 excluded.

The results this year and the average results also, although to a greater extent, indicate that the yields are increased when the land is fallowed for the wheat crop.

TIME OF PLOUGHING EXPERIMENT.

The object of this experiment is to ascertain whether the time of carrying out the initial operation of fallowing, *i.e.*, ploughing, has any effect upon the yield of the resultant wheat crop.

The results are as hereunder:—

TIME OF PLOUGHING EXPERIMENT, 1937.

Planted on 3rd May, 1937. Superphosphate—90lbs. per acre.
Germinated on 18th May, 1937. Variety—Gluyas Early. Seed—45lbs. per acre.

When Ploughed.	Average Yields per acre. bus. lb. 1937	Percentage Yields. % 1937	Average Yields per acre. bus. lb. 1930–37.*	Percentage Yields. % 1930–37.*
March, 1936	11 4	94	10 32	72
June, 1936	11 44	100	14 40	100
August, 1936	11 44	100	14 16	97

* 1936 excluded.

The average results over the past seven years show that the initial operation of fallowing is best carried out during the early winter months.

DEPTH OF PLOUGHING EXPERIMENT.

The object of this experiment is to ascertain the most economical depth to plough when fallowing for the wheat crop.

DEPTH OF PLOUGHING EXPERIMENT, 1937.

Planted on 3rd May, 1937. Superphosphate—90lbs. per acre.
Germinated on 18th May, 1937. Variety—Gluyas Early. Seed—45lbs. per acre.

Depth Ploughed.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1930–37.*	Percentage Yields. % 1930–37.*
2in.	9 20	86	13 28	91
4in.	10 48	100	14 48	100
6in.	10 52	101	14 32	98

* 1936 excluded.

The results indicate that it is most economical to plough to a depth of 4 inches.

In addition to a lower yield being obtained from the plot ploughed 2 inches deep, it was found necessary for it to receive extra cultivation to maintain the desired tilth.

MULCHING EXPERIMENT.

The object of this experiment is to ascertain to what extent and under what conditions the cultivation of winter fallowed land is profitable during the spring and summer months.

To meet the requirements of the experiment, 3 plots were treated as follows:—

Plot 1.—Cultivated prior to seeding only (neglected fallow).

Plot 2.—Cultivated during spring and prior to seeding (ordinary fallow).

Plot 3.—Cultivated during spring when required during summer, i.e. after 25 points of rain or more, and again prior to seeding.

This year Plot 3 was cultivated on August 24th, 1936, October 1st, 1936, November 26th, 1936, January 13th, 1937, and prior to seeding, while Plot 2 was cultivated on August 24th, 1936, and prior to seeding.

MULCHING EXPERIMENT, 1937.

Planted on 4th May, 1937. Superphosphate—90lbs. per acre.
Germinated on 18th May, 1937. Variety—Gluyas Early. Seed—45lbs. per acre.

Treatment.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1929–37.*	Percentage Yields. % 1929–37.*
Cultivated before seeding only ...	13 12	112	15 44	100
Cultivated in spring and before seeding	11 44	100	15 44	100
Cultivated in spring, after summer rain, and before seeding	10 48	92	15 44	100

* 1936 excluded.

The average results over a period of this experiment indicate that there is no advantage to be gained by spring or summer cultivations, whilst the results of last year's experiments indicate that these cultivations may have a deleterious effect. These experiments and general experience at this and other stations have

shown that the fallow should only be cultivated when special circumstances warrant it, such as after excessive rain which may cause the land to set hard or produce a heavy weed growth which cannot be controlled by stock. Spring and summer cultivation is likely to destroy the consolidation and seed bed in light types of soil and so have a depressing effect on the yield. Autumn cultivation after rains is necessary, of course, particularly where weeds are expected.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT.

The object of this experiment is to determine the most economical rate to apply superphosphate to the wheat crop.

RATE OF SUPERPHOSPHATE EXPERIMENT, 1937.

SECTION 1.

Planted on 4th May, 1937. Germinated on 18th May, 1937. Variety—Gluyas Early.
Seed—45lbs. per acre.

Rate of Superphosphate per Acre.	Average Yields per acre.		Per-centage Yields.	Average Yields per acre.		Per-centage Yields.
	bus.	lb.	%	bus.	lb.	%
	1937.		1937.	1929–37.*		1929–37.*
Nil	5	20	47	6	56	42
150lbs.	11	28	100	16	40	100
75lbs.	10	0	87	14	98	89

* 1930 and 1936 excluded.

RATE OF SUPERPHOSPHATE EXPERIMENT, 1937.

SECTION 2.

Planted on 4th May, 1937. Germinated on 18th May, 1937. Variety—Gluyas Early.
Seed—45lbs. per acre.

Rate of Superphosphate per Acre.	Average Yields per acre.		Per-centage Yields.	Average Yields per acre.		Per-centage Yields.
	bus.	lb.	%	bus.	lb.	%
	1937.		1937.	1929–37.*		1929–37.*
225lbs.	10	16	96	16	24	102
150lbs.	10	40	100	16	8	100
300lbs.	10	0	94	16	32	102

* 1930 and 1936 excluded.

This year's results and those of previous years indicate that the rate of application of superphosphate can be increased with advantage above 75 lbs. per acre and that the most economical rate on this class of country under present conditions would be approximately 100 lbs. per acre.

POTASH-NITROGEN EXPERIMENT.

The object of this experiment is to determine the effect upon the grain yield of the wheat crop from the application of:—

(a) A nitrogenous fertiliser.

(b) A nitrogenous fertiliser + a potassic fertiliser when used in conjunction with superphosphate.

Sulphate of ammonia, a nitrogenous fertiliser, and sulphate of potash, a potassic fertiliser, were used in addition to superphosphate. The results were as follows:—

POTASH-NITROGEN EXPERIMENT, 1937.

Planted on 11th May, 1937. Germinated on 18th May, 1937. Variety—Gluyas Early. Seed- 45lbs. per acre.

Rate of Fertiliser per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.	Percentage Yields. % 1932–37.
1 cwt. superphosphate; 1 cwt. sulphate of ammonia	10 8	97	14 48	100
1 cwt. superphosphate	10 24	100	14 48	100
1 cwt. superphosphate · 1 cwt. sulphate of ammonia, 1 cwt. potash	9 52	95	14 48	100

The average results since the inception of this experiment show that no increase in yield follows the application of these fertilisers in addition to superphosphate.

RATE OF SEEDING EXPERIMENT.

The object of this experiment is to ascertain the most economical rate of seeding with:—

(a) A mid-season free stooling variety.

(b) An early sparse stooling variety.

To meet these requirements the variety Bencubbin was used in the first case and Noongaar in the second.

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 1st May, 1937. Superphosphate—90lbs. per acre.
Germinated on 18th May, 1937. Variety—Bencubbin.

Rate of Seed per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.*	Percentage Yields. % 1929–37.*
30lbs.	9 36	90	13 36	103
45lbs.	10 40	100	13 12	100
60lbs.	10 40	100	13 4	99

* 1936 excluded.

RATE OF SEEDING EXPERIMENT, 1937.

Planted on 22nd May, 1937. Superphosphate—90lbs. per acre.
Germinated on 26th May, 1937. Variety—Noongaar.

Rate of Seeding per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1931–37.*	Percentage Yields. % 1931–37.*
30lbs.	9 12	98	15 20	96
45lbs.	9 20	100	16 8	100
60lbs.	9 36	103	16 8	100

* 1936 excluded.

The average results indicate that there is no advantage in sowing at a greater rate than 30 lbs. of graded seed per acre for the mid-season free stooling variety Bencubbin, or more than 45 lbs. per acre for the early sparse stooling variety Noongaar.

TIME OF PLANTING EXPERIMENT.

The object of this experiment is to determine the most suitable month in which to plant an early and a very early maturing wheat variety.

Two varieties were used, the early variety Gluyas Early, planted in April, May and June, and the very early variety Noongaar, planted in May, June and July.

TIME OF PLANTING EXPERIMENT, 1937.

Superphosphate—90lbs. per acre. Variety—Gluyas Early. Seed—45lbs. per acre.

Planted on—	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.*	Percentage Yields. % 1932–37.*
15th April	8 24	78	13 44	95
13th May	10 48	100	14 32	100
15th June	6 8	57	8 8	56

* 1936 excluded.

TIME OF PLANTING EXPERIMENT, 1937.

Superphosphate—90lbs. per acre. Variety—Noongaar. Seed—45lbs. per acre.

Planted on—	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.*	Percentage Yields. % 1932–37.*
16th June	10 32	103	14 0	91
17th May	10 16	100	15 28	100
15th July	2 8	21	5 12	34

* 1936 excluded.

The results for this year and average results for the four previous years indicate that May is the best month to sow the wheat crop.

SEASONAL PLANTING EXPERIMENT.

The objects of this experiment are:—

(a) To ascertain the most suitable month to plant the mid-season, early and very early maturing varieties of wheat;

(b) To determine the most prolific of each of the above types.

To meet the requirements of the experiment, three sections were planted, viz.:—

(a) Section 1, planted in April, representing early planting.

(b) Section 2, planted in May, representing mid-season planting.

(c) Section 3, planted in June, representing late planting.

SEASONAL PLANTING EXPERIMENT, 1937.

APRIL PLANTING.

Planted on 16th April, 1937. Superphosphate—90 lbs. per acre.
Germinated on 20th April, 1937. Seed—45 lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs.	Percentage Yields. % 1931–37.*
Bencubbin	7 44	100	...	103
Gluyas Early	7 44	100	...	100
Nabawa	6 16	81	...	87
Totadgin	6 56	95	...	100†
Gluyas Early	7 20	100	...	100
Carrabin	5 28	75	...	86
Merredin	6 32	84	...	97
Gluyas Early	7 44	100	...	100
Noongaar	5 36	72	...	85

* 1935–36 excluded. † 1932–37.

MAY PLANTING.

Planted on 14th May, 1937. Superphosphate—90lbs. per acre.
Germinated on 18th May, 1937. Seed—45lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937	Percentage Yields. % 1937	Average Yields per acre. bus. lb.	Percentage Yields. % 1931–37.*
Merredin	6 8	81	...	93
Gluyas Early	7 36	100	...	100
S.H.J.	5 4	67	...	74
Bencubbin	9 36	113	...	103
Gluyas Early	8 32	100	...	100
Nabawa	8 16	97	...	83
Totadgin	7 36	93	...	101†
Gluyas Early	8 8	100	...	100
Carrabin	7 36	93	...	88
Geeralying	5 44	67	...	75
Gluyas Early	8 32	100	...	100
Noongaar	6 56	81	...	94

* 1936 excluded. † 1932–37.

JUNE PLANTING.

Planted on 16th June, 1937. Superphosphate—90lbs. per acre.
Germinated on 21st June, 1937. Seed—45lb. per acre.

Variety.	Average Yields per acre. bus. lb. 1937	Percentage Yields. % 1937	Average Yields per acre. bus. lb.	Percentage Yields. % 1931–37.*
Merredin	7 4	87	...	85
Gluyas Early	8 8	100	...	100
S.H.J.	8 8	100	...	99
Totadgin	7 44	100	...	97†
Gluyas Early	7 44	100	...	100
Bencubbin	6 24	83	...	72†
Geeralying	7 36	98	...	94
Gluyas Early	7 44	100	...	100
Noongaar	8 0	103	...	113

* 1936 excluded. † 1934–37.

In the April section, Bencubbin and Gluyas Early (the control) are the best yielders followed by Totadgin. From past experience there is a definite danger of loss through either frost or septoria in planting an early maturing variety in April; it is, therefore, recommended that the mid-season variety Bencubbin be planted during this month.

Bencubbin is again outstanding in the May section and in the average results is closely followed by Totadgin and Gluyas Early. In the June section Noongaar, a very early variety, has given best results for this and previous years and is recommended for the later half of May.

Experience and the results of these experiments emphasise the necessity for completing the seeding operations by the end of May. It is therefore recommended that for April planting the mid-season variety Bencubbin be used; for the first half of May the early varieties Gluyas Early and Totadgin and for the latter half, Noongaar.

FUNGICIDE EXPERIMENT.

The object of this experiment is to determine the effect upon the germination, growth and grain yield of the use of a finely powdered organic mercury compound and copper carbonate as fungicides for wheat.

The experiment was initiated in 1936, but on account of the seasonal conditions, the results were discarded.

FUNGICIDE EXPERIMENT, 1937.

Planted on 22nd May, 1937. Superphosphate—90lbs. per acre.
Germinated on 27th May, 1937. Variety—Noongaar. Seed—45lbs. per acre.

Treated with—	Average Yields per acre.	Per-centage Yields.	Average Yields per acre.	Per-centage Yields.
	bus. lb.	%	bus. lb.	%
	1937.	1937.		
Mercury Compound	9 36	99	..	...
Seed untreated	9 44	100	..	...
Copper Carbonate	10 0	103	...	..

No difference could be detected regarding the germination and growth of any of the plots, and there was no significant difference in yield of the treated and untreated seed. Further experiments will be necessary before definite conclusions may be drawn.

SALMON GUMS RESEARCH STATION.

J. M. MOULTON,
Farm Manager.

The monthly rainfalls as recorded at the Station during 1937, together with the average for the past 12 years, were as follow:—

Year.	Jan.	Feb.	Mar.	Apl.	Growing Period. May.	June.	July.	Aug.	Sept.	Oct.	Total.	Nov.	Dec.	Total for Year.
1937	68	159	251	78	153	106	29	196	148	63	695	229	8	1,488
Av., 12 years	56	59	147	99	132	133	142	172	89	108	776	94	64	1,295

The rainfall for the greater part of the season was favourable for the growth of the crops. The heavy rains which fell in February and March facilitated the preparation of a good seed-bed in addition to assuring reserves of moisture in the subsoil. Seeding operations were carried out under ideal conditions and the germination was excellent.

The land on which the Rate of Superphosphate, Time of Seeding and Potash-Nitrogen experiments were planted was a red sandy loam typical of the more satisfactory wheat soils of the district.

This land, and also that on which the Kopi Experiments were planted, was ploughed with a disc cultivating plough in June and July, 1936, to a depth of 3-4 inches and springtyne cultivated immediately after ploughing. In August it was cultivated to the full depth with a rigid tyne cultivator and again after heavy rains in early January, February and March. Further cultivation with the same implement was given prior to seeding.

The land on which the Clay Soil Experiment was planted was ploughed during the first week in July, 1936, with a mouldboard plough to a depth of 3-4 inches, and was rigid tyne cultivated to the full depth of ploughing at the end of August,

after heavy rains in February and in mid April. After rain on 13th May it was springtyne cultivated and owing to further rain, again before seeding.

TIME OF SEEDING EXPERIMENT.

The object of this experiment is to determine the most suitable month in which to plant the wheat crop. To meet the requirements of the experiment, a midseason maturing variety Bencubbin was planted in mid April, May and June, and an early maturing variety Gluyas Early in mid May, June and July.

TIME OF SEEDING EXPERIMENT.

Superphosphate—112lbs. per acre. Variety—Bencubbin. Seed—45lbs. per acre.

Date Planted.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1928–37.	Percentage Yields. % 1928–37.
19th April	9 36	64	13 4	97
18th May	14 56	100	13 28	100
15th June	11 28	77	9 44	72

TIME OF SEEDING EXPERIMENT.

Superphosphate—112lbs. per acre. Variety—Gluyas Early. Seed—45lbs per acre.

Date Planted.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lbs. 1928–37.	Percentage Yields. % 1928–37.
18th May	13 28	100	14 32	100
15th June	17 28	130	12 0	83
14th July	10 8	75	8 56	61

From the results in 1937, it would appear that May is the best month for planting the midseason variety Bencubbin However, the difference in average yields between the April and May sown plots is not significant, and seeding with a midseason variety could, therefore, commence with safety about the middle of April. In 1937 the best yields were obtained by planting the early maturing variety Gluyas Early in June However, the average results for nine years indicate that the yields are decreased when seeding extends after the end of May.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT.

The object of this experiment is to ascertain the most profitable rate of superphosphate to apply to the wheat crop.

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT.
No. 1.

Planted on 20th May, 1937. Germinated on 30th May, 1937. Variety—Gluyas Early.
Seed—45lbs. per acre.

Rate of Application of Superphosphate per Acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1929–37.	Percentage Yields. % 1929–37.
Nil	9 36	62	6 56	45
150lbs.	15 28	100	15 28	100
75lbs.	13 20	86	13 28	87

RATE OF APPLICATION OF SUPERPHOSPHATE EXPERIMENT.

No. 2.

Planted on 19th June, 1937. Germinated on 30th June, 1937. Variety—Gluyas Early. Seed—45lbs. per acre.

Rate of Application of Superphosphate per Acre.	Average Yields per acre.	Percentage Yields.	Average Yields per acre.	Percentage Yields.
	bus. lb.	%	bus. lb.	%
	1937.	1937.	1929–37.	1929–37.
225lbs.	20 32	110	17 28	105
150lbs.	18 40	100	16 40	100
300lbs.	21 12	114	17 28	105

The results in 1937 and the averages for the past nine years indicate that the rate of superphosphate can be increased with advantage above 75 lbs. per acre. The most economical rate on this class of soil, under present conditions, would be about 90-100 lbs. per acre.

POTASH-NITROGEN EXPERIMENT.

The object of this experiment is to determine the effect upon the grain yield of the wheat crop of the application of—

(a) a nitrogenous fertiliser.

(b) a nitrogenous fertiliser plus a potassic fertiliser

in addition to the usual application of superphosphate.

Sulphate of Ammonia, a nitrogenous fertiliser, and Sulphate of Potash, a potassic fertiliser, were used.

POTASH-NITROGEN EXPERIMENT.

Planted on 18th May, 1937. Germinated on 30th May, 1937. Variety—Gluyas Early. Seed—45lbs. per acre.

Rate of Application of Fertiliser per Acre.	Average Yields per acre.	Percentage Yields.	Average Yields per acre.	Percentage Yields.
	bus. lb.	%	bus. lb.	%
	1937.	1937.	1932–37.	1932–37.
112lbs. Superphosphate plus 112 lbs. Sulphate of Ammonia	10 24	108	14 0	101
112lbs. Superphosphate	9 36	100	13 52	100
112lbs. Superphosphate plus 56 lbs. Sulphate of Potash plus 112lbs. Sulphate of Ammonia	10 24	108	13 28	97

The results in 1937 show that a slight increase in yield is obtained by the application of the nitrogenous fertiliser, in addition to the superphosphate, but that no further increase results from the potassic fertiliser in addition.

The average results, however, for the nine years the experiment has been conducted indicate that no significant increase in the grain yield is obtained from the application of a nitrogenous and a potassic fertiliser in addition to superphosphate.

EXPERIMENTS ON "KOPI" SOILS.

Owing to the unsatisfactory crops of wheat generally obtained from the so-called "Kopi" soils in the Salmon Gums area, experiments have been conducted with a view of obtaining definite information regarding crop response on this class of soil. The original vegetation included giant mallee, a variety of *Eucalyptus oleosa*, and a member of the red morrel family.

The Salmon Gums "Kopi" is described as a light grey highly calcareous soil. It is fairly powdery and represents grey morrel soil of the Eastern Wheat Belt. With working it tends to become a little more compact.

OAT VARIETY TRIAL.

The object of this experiment is to ascertain the most suitable oat to plant on this type of soil.

OAT VARIETY TRIAL.

Planted on 19th April, 1937. Superphosphate—112lbs. per acre.
Germinated on 1st May, 1937. Seed—45lbs. per acre.

Variety.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1931–37.*	Percentage Yields. % 1931–37.*
Mulga	6 0	75	9 0	96
Algerian	7 32	100	9 32	100
Guyra	6 24	80	10 0	104

* 1934 excluded.

The result in 1937 was in favour of the late maturing variety Algerian. The average results for the six years the experiment has been conducted are slightly in favour of the midseason maturing variety Guyra.

MANURIAL EXPERIMENT.

To determine the effect on the grain yield of the wheat crop planted on this type of soil, when applications of heavy dressings of stable manure and also of a mixed fertiliser are made in addition to the usual application of superphosphate.

For the purpose of this experiment, three plots were required, and received the following applications of fertiliser—

Plot 1. 1 cwt. of superphosphate and 15 tons of stable manure per acre.

Plot 2. 1 cwt. of superphosphate per acre.

Plot 3. 1 cwt. of superphosphate and 120 lbs. per acre of mixed fertiliser consisting of Manganese Sulphate, Borax, Zinc Sulphate, Magnesium Sulphate, Copper Sulphate and Iron Sulphate. Thus each was applied at the rate of 20 lbs. per acre. This is the first year that the mixed fertiliser has been used, Manganese Sulphate at the rate of 56 lbs. per acre being previously used. There was, however, no significant increase in yield from the use of this fertiliser.

MANURIAL EXPERIMENT.

Planted on 20th May, 1937. Superphosphate—112lbs. per acre.
Variety—Gluyas Early. Seed—45lbs. per acre.

Rate of Application of Fertiliser per acre.	Average Yields per acre. bus. lb. 1937.	Percentage Yields. % 1937.	Average Yields per acre. bus. lb. 1932–37.	Percentage Yields. % 1932–37.
112lbs. Superphosphate plus 15 tons Stable Manure	11 52	210	10 32	186
112lbs. Superphosphate	5 36	100	5 44	100
112lbs. Superphosphate plus 120 lbs. Mixed Fertilisers	5 52	105	...	...

The results in 1937 confirm those of the previous six years that heavy dressings of stable manure, in addition to superphosphate, will definitely increase the grain yields. No significant increase in yield was obtained from the application of the mixed fertiliser.

FODDER TRIAL.

The object of this trial is to ascertain the relative yields of green fodder obtained from the common fodder plants when planted on this type of soil. Sulphate of ammonia at the rate of 1 cwt. per acre was applied to certain plots of Mulga oats and Wimmera rye grass to ascertain if this would increase the yield of fodder.

The yields of the green fodders were calculated by taking cuttings from quadrats of one square yard in area systematically through the respective plots.

The yields are shown hereunder.

FODDER EXPERIMENT—KOPI SOIL.

YIELD OF GREEN FODDER.

Planted on 20th April, 1937. Superphosphate—112lbs. per acre. Germinated on 1st May, 1937.

Fodder.	Rate of Seed per acre.	Average Yields per acre.	Percentage Yields.	Average Yields per acre.	Percentage Yields.
	lbs.	tons.	%	tons.	%
		1937.	1937.	1933–37.*	1933–37.*
Gluyas Early	45	0·47	54	0·66	62
Mulga Oats (Control) . .	40	0·87	100	1·07	100
Mulga Oats plus 1 cwt. Sulphate of Ammonia	40	0·89	103	1·18	110
Rye	40	0·89	117	1·60	168
Wimmera Rye Grass (control)	4	0·76	100	0·97	100
Wimmera Rye Grass plus 1 cwt. Sulphate of Ammonia	4	0·85	112	1·01	106

* 1934 excluded.

In 1937 almost similar yields were obtained from Rye, Mulga oats, and Mulga oats receiving an application of 1 cwt. of Sulphate of Ammonia per acre. Increased yields were also obtained from the Wimmera Rye Grass receiving an application of Sulphate of Ammonia. The average results for the four years the experiment has been conducted indicate that the best yield of green fodder is obtained from Rye and that the applications of 1 cwt. of Sulphate of Ammonia, in addition to superphosphate to Mulga oats and Wimmera Rye Grass has increased the green fodder yield.

FODDER EXPERIMENT.

The object of this experiment is to ascertain which of the cereals, wheat, oats and rye, gives the best grain yields on "Kopi" soils.

In addition to the usual application of 1 cwt. of superphosphate per acre, certain of the Mulga oats plots received an application of 1 cwt. of Sulphate of Ammonia per acre.

FODDER EXPERIMENT.

GRAIN YIELD.

Planted on 20th April, 1937. Superphosphate—112lbs. per acre. Germinated on 1st May, 1937.

Fodder.	Rate of Seed per acre.	Average Yields per acre.	Percentage Yields.	Average Yields per acre.	Percentage Yields.
	lbs.	tons.	%	tons.	%
		1937.		1935–37.	
Gluyas Early	45	157	75	408	202
Mulga Oats (Control)	40	208	100	202	100
Mulga Oats plus 1 cwt. Sulphate of Ammonia	40	251	121	206	102
Rye	40	181	87	282	140

Because of the difference in the bushel weight of the cereals the results are expressed in pounds instead of bushels. The yields from all cereals on this soil are low.

In 1937 the plots of Mulga oats receiving an application of 1 cwt. of sulphate of ammonia have given the best result. The average results for the three years the experiment has been conducted indicate that the highest yields are obtained from the early maturing wheat variety Gluyas Early. Rye has also yielded very well. They also show that increased yields of Mulga oats obtained from applications of sulphate of ammonia are not sufficient to warrant the extra cost of application.

FODDER EXPERIMENTS ON CLAY SOIL.

In addition to the experiments on "Kopi" soils, experiments were also conducted on the heavy clay soils.

The object of these experiments is to determine the most suitable crops either as grain or fodder crops on this type of soil under field conditions.

FODDER EXPERIMENT.

Yield of Green Fodder.

Planted on 17th May, 1937. Superphosphate—112lbs. per acre. Germinated on 27th May, 1937.

Variety.	Rate of Seed per acre.	Average Yields per acre.	Percentage Yields.	Average Yields per acre.	Percentage Yields.
	lbs.	tons.	%	tons.	%
		1937.	1937.	1935–37.	1935–37.
Gluyas Early	45	1·44	110	1·27	115
Bencubbin (Control)	45	1·31	100	1·10	100
Atlas Barley	40	1·77	136	1·70	154
Mulga Oats	40	1·18	60	1·05	73
Rye (Control)	45	1·97	100	1·44	100
Wimmera Rye	6	1·31	67	1·00	69

In 1937 for fodder purposes Rye followed by Atlas barley, gave the best results. Over the three years the experiment has been conducted the Atlas barley has yielded to advantage.

Grain Yields.

Because of the difference in the bushel weights of the various cereals, the grain yields are shown in pounds instead of bushels. The results were as follow:—

FODDER EXPERIMENT.

GRAIN YIELDS.

Planted on 17th May, 1937. Superphosphate—112lbs. per acre. Germinated on 24th May, 1937.

Fodder.	Rate of Seed per acre.	Average Yields per acre.	Percentage Yields.	Average Yields per acre.	Percentage Yields.
	lbs.	lbs.	%	lbs.	%
		1937.	1937.	1935–37.	1935–37.
Gluyas Early	45	765	77	592	97
Bencubbin (Control)	45	995	100	608	100
Atlas Barley	40	752	76	648	107
Mulga Oats	40	462	65	216	44
Rye (Control)	45	669	100	496	100
Wimmera Rye	6	101	15	....	....

In 1937 the midseason maturing wheat variety Bencubbin has given the highest grain yield. This has also yielded well over the three years the experiment has been conducted and is only slightly exceeded by Atlas barley.

POTATO FERTILISER TRIALS AT BUREKUP, 1937.

E. T. MORGAN,
Officer in Charge, Potato Branch.

A new departure in fertiliser experiments with potatoes in this State, and possibly in the Commonwealth, was made at Burekup during the past season, where the trials were inaugurated to ascertain whether any effect or none was to be derived from the inclusion of certain minor elements in the fertiliser mixtures. These elements, as well as the layout of the trials, were suggested by Dr. L. J. H. Teakle, Plant Nutrition Officer of this Department and to whom I am indebted for the analyses of the figures tabulated.

The fertiliser treatments were:—

Treatment No.	Sulphate of Ammonia. Cwts. per acre.	Superphosphate. Cwts. per acre.	Sulphate of Potash. Cwts. per acre.
1	4	4	2
2	4	4	2
+ 20 lbs. each of Sulphates of Zinc, of Copper, of Manganese, and of Magnesium.			
3	4	12	2 (Control)
4	4	12	2
+ 20 lbs. each of Sulphates of Zinc, of Copper, of Manganese, and of Magnesium.			
5	Blood equivalent to 4 cwts. Sulphate of Ammonia	12	2
6	Blood equivalent to 2 cwts. Sulphate of Ammonia + 2 cwts. Sulphate Ammonia.	12	2

The plan adopted was a 6 by 6 Latin square the individual plots being 16 yards long by 4 rows wide, the two centre rows being weighed at the time of digging for the purpose of comparison, the outside rows being treated as buffers.

Every farmer is familiar with the great degree of crop variation which obtains in a potato field even when the soil is apparently unform. Some years ago in consequence of such differences, the system of replication was adopted This consisted of repeating the same plots several times in the same paddock and the 6 by 6 Latin square adopted in the experiments allowed of the 6 treatments 1, 2, 3, 4, 5 and 6 being repeated at random 6 times. This permits a mathematical analysis of the results by means of which it can be determined if such differences are likely to be brought about by the position of the plots in the field or may be due to experimental error.

The land chosen for the experimental work was a heavy clay loam and it is typical of much of the potato growing land in the Brunswick, Burekup and Waterloo areas.

The land in question had been planted in the previous season with potatoes and was chosen because in this particular type of country, a trouble known to many growers as rust or bronzing of the foliage of potato plants was prevalent and has shown in this area, to my knowledge, for the past 20 years.

It was first thought that wet conditions were responsible for the trouble but subsequent observations and collaboration with Mr. H. A. Pittman, Plant Pathologist, has suggested that some soil deficiency may be responsible.

As such apparent disease is worse in any paddock after its having been planted with potatoes in successive years, it was considered that trials embodying minor elements would prove interesting and informative on such land. The site of the trials was ploughed at the period of the early autumn rains, in April, and was well harrowed prior to planting which took place on the 9th, 10th and 11th of June. The area was planted with large certified seed grown at Denmark and

was cut into sets of from 1½ to 2 ozs., the land being ploughed to a depth of about 4½ inches, the sets being planted at a depth of about 3 inches. To facilitate drainage and allow of equal conditions throughout, 4 rows were planted at about 30 inches apart in each "land," which was fairly well "crowned up." All the fertiliser was applied along the furrow at the time of planting, the minor elements being incorporated in the manurial mixtures.

The usual cultivations and hand hoeing for the control of weeds were carried out and "moulding up" of the crop completed the cultivation. The harvesting of the crop took place during the third week in October.

The weather at the time of planting was ideal, but cold and rather wet conditions were experienced during July and August. During September and early October the conditions were good and ample rain fell prior to harvesting.

The results of the trials are attached below:—

Set.	Fertiliser Treatment. Per acre.	Average Yield of 6 Plots. lbs.	Computed Yields (tons per acre). tons cwts.	Percentage of average yield of the experiment. %
1	4 cwts. Sulphate of Ammonia ... 4 „ Superphosphate ... ... 2 „ Sulphate of Potash ...	489	7 5	89.3
2	4 cwts. Sulphate of Ammonia ... 4 „ Superphosphate ... 2 „ Sulphate of Potash ... 20 lbs. Sulphate of Zinc ... ... 20 „ „ „ Copper ... 20 „ „ „ Manganese ... 20 „ „ „ Magnesium ...	499	7 8	91.1
3	4 cwts. Sulphate of Ammonia ... 12 „ Superphosphate ... 2 „ Sulphate of Potash (Control)	560	8 6	102.2
4	4 cwts. Sulphate of Ammonia ... 12 „ Superphosphate ... 2 „ Sulphate of Potash ... 20 lbs. Sulphate of Zinc ... ... 20 „ „ „ Copper ... 20 „ „ „ Manganese ... 20 „ „ „ Magnesium ...	549	8 3	100.2
5	Blood equivalent to 4 cwts.... Sulphate of Ammonia ... 12 cwts. Superphosphate ... 2 „ Sulphate of Potash ...	591	8 15	107.8
6	Blood equivalent to 2 cwts. Sulphate of Ammonia ... ... 2 cwts. Sulphate of Ammonia 12 „ Superphosphate ... 2 „ Sulphate of Potash ...	597	8 17	108.9

Standard error per treatment yield is 5.2 cwts. per acre.

These results show that no benefit was derived by the use of minor elements included in the fertiliser mixtures. The analysis of the table indicates that the only significant increase in crop was obtained by the application of 12 cwt. superphosphate per acre in the mixtures as against 4 cwt. per acre.

A second series of experiments was carried out, the layout being identical with the previous trials. This series was devised to ascertain the effects in fertiliser mixtures of:—

A. (1) Sulphate of potash applied to the land one month prior to planting.

(2) Potash applied in the furrow at planting time.

(3) Potash applied as a top dressing at the period of the emergence of the plants.

B. (1) Sulphate of ammonia applied in the furrow at the time of planting.

(2) Half the ammonia being applied at planting time and half as a top dressing at the period of emergence.

(3) The application of a further 2 cwt. per acre as a top dressing.

There has been a tendency in the last few years in the South-West, for growers to heavily top dress the spring crop with sulphate of ammonia, some growers using 3 bags per acre. The Potato Branch has recommended sulphate of ammonia as a top dressing at the rate of 1½ to 2 cwts. per acre.

It is desired to ascertain if such a heavy dressing is correspondingly beneficial, therefore these trials will be repeated in the future.

The site of the trials was marked out one month prior to planting, which took place at the same period as the foregoing experiment, and the plots, which were to be predressed with sulphate of potash, had this material applied and harrowed in.

The other fertiliser mixtures were applied in the furrow with the potato sets as planting proceeded. In the case of the sulphate of ammonia this constituent was halved in two cases and the desired quantities used as a top dressing soon after the time of the emergence of the plants on August 1st, heavy rain following its application.

The results are tabulated below:—

Set.	Fertiliser Treatment.	Average Yield of 6 Plots.	Computed Yields (tons per acre).	Percentage of average yield of the experiment.
	Per acre.	lbs.	tons cwt.	%
1	4 cwts. Sulphate of Ammonia .. 12 ,, Superphosphate (Control) ... ... 2 ,, Sulphate of Potash .. All fertiliser applied in furrow ...	493	7 6	94.3
2	4 cwts. Sulphate of Ammonia ... 12 ,, Superphosphate ... 2 ,, Sulphate of Potash ... Potash pre-dressed 1 month before planting	486	7 4	92.9
3	4 cwts. Sulphate of Ammonia ... 12 ,, Superphosphate ... 2 ,, Sulphate of Potash ... Potash top-dressed at emergence of plants	494	7 7	94.5
4	4 cwts. Sulphate of Ammonia ... 12 ,, Superphosphate ... 0 ,, Sulphate of Potash ...	440	6 10	84.1
5	2 cwts. Sulphate of Ammonia ... 12 ,, Superphosphate ... 2 ,, Sulphate of Potash ... 2 ,, Sulphate of Ammonia ... Top-dressed on emergence	618	9 3	118
6	2 cwts. Sulphate of Ammonia ... 12 ,, Superphosphate ... 2 ,, Sulphate of Potash ... 4 ,, Sulphate of Ammonia ... Top-dressed on emergence	608	9 0	116

Standard error per treatment yield is 4.9 cwts. per acre.

In the case of the nitrogen trials there is a most significant increase where the sulphate of ammonia was divided, 2 cwts. per acre at planting time with 2 cwts. applied as a topdressing against the 4 cwts. all applied at planting time.

It is interesting to note that no increase was obtained by the addition of extra ammonia as a topdressing. During the growing period no difference in the top-dressed plots was noted. If anything, growth seemed to favour the plots which had received the 2 cwts. per acre. The actual figures indeed show slightly in favour of these plots, but the increase is not significant.

It would appear from these trials that the extra quantity of sulphate of ammonia is not economically sound but one swallow does not make a summer and these trials will be repeated.

Response to Potash. Control of Rust or Bronzing of potato foliage.

In the case of the potash series an interesting development occurred. There was an almost total absence of the so-called rust or bronzing in those plots that had received potash, whilst the no-potash plots were badly affected.

The presence of this trouble always has the effect of seriously affecting the yield and indeed the results from the "no potash" plots were worse than the actual figures reveal. In the two furrow rows in each plot, being treated as buffers, the tubers were not weighed and in some instances hardly any ware potatoes were dug, whereas in all the plots which had received a complete manure there was apparently little difference in the yields of the "furrow" and "crown" rows.

At this stage of the trials, I do not intend to convey the idea that this trouble is caused solely by a potash deficiency. but two years ago I had an indication that this constituent materially assisted in checking the apparent disease, and this year's results show a similar effect.

That a wet soil condition aggravates the trouble is well known to me, as I have never observed this phenomenon on the higher hill soils, and it seems to be prevalent only on the "plain" country. The trouble has been definitely on the increase during the past few years, and this may be due in some measure to the heavy nitrogen manuring with little or no potash in the fertiliser mixtures.

For many years in the South-West from Harvey to Dardanup, potatoes have been planted with a fertiliser containing no potash. The potato is noted for its necessity for a well-balanced fertiliser, and these trials would suggest that about 2 cwts. of sulphate of potash per acre should be applied in the fertiliser mixture used. Thus, if we take a "potato manure" containing, say, 8 per cent. of potash (sulphate of potash is 48 per cent. potash), about 12 cwt. per acre would give an equivalent amount to that used in the trials.

For the benefit of those growers who are not familiar with this "rust" or bronzing of potatoes, the symptoms are here outlined. As the potato plants approach the flowering period, the foliage turns very dark, almost a bluey-green, glossy, with a ridging of the leaf between the veins; later a colour change takes place, the leaf between the veins showing firstly as a yellow tinge, later turning to a rusty or bronze colour; the leaves become brittle and roll upwards.

Numerous dark spots are observed on the leaves and in the last stages the leaves blacken, the tops of the plants often show aerial tubers (as in the case of plants affected with Rhizoctonia), and in many instances the tubers are affected, showing a purpley-black stain on the stem ends of the potatoes. If such tubers are bagged immediately after digging, sweating seems to take place and much rot is occasioned. If such potatoes, however, are allowed to remain in the sun,

without, of course, being allowed to be sunburned, the affected portion dries up and further decay is apparently arrested.

I wish to stress the fact that, while it is not suggested that potash deficiency is responsible, the fertiliser trials have given an indication that well-balanced fertilisers will alleviate to a great extent the effects of the trouble, and it is hoped that growers will benefit by the early publication of the first of a series of such experiments.

Summary.

(1) The inclusion of certain minor elements in fertiliser mixtures in heavy soil at Burekup did not appear to have any beneficial result on the potato crop.

(2) Twelve hundredweight of superphosphate per acre in the fertiliser mixture gave an increased yield over 4 cwt. per acre so applied.

(3) No difference was apparent in the various methods of the application of potash whether predressed one month prior to planting, sown at planting time, or applied as a top-dressing at the time of the emergence of the plants.

(4) The plots which had received no potash showed a decreased yield which was occasioned by the presence of so-called "rust" or "bronzing" of the potato foliage.

(5) There was a significant increase in yield where half the sulphate of ammonia was applied in the furrow at planting time and half used as a top-dressing when the plants emerged.

(6) There was no beneficial effect by using an extra 2 cwt. of sulphate of ammonia per acre as a top-dressing.

(7) The heaviest yield was obtained with a mixture of 4 cwt. of sulphate of ammonia, 12 cwt. of superphosphate and 2 cwt. of sulphate of potash per acre, 2 cwt. of sulphate of ammonia being applied at planting time and 2 cwt. as a top-dressing when the plants were just through the ground. The analysis of the above mixture approximates 2.57 per cent. nitrogen, 16.5 per cent. phosphoric acid, and 6 per cent. potash, plus 2 cwt. of sulphate of ammonia as a top-dressing.

(8) The use of blood to replace sulphate of ammonia in the fertiliser mixture has not shown any significant effect on the yield.

THE OCCURRENCE OF SOLONETZ (STRUCTURAL ALKALI) SOILS IN WESTERN AUSTRALIA.

G. H. BURVILL[1] and L. J. H. TEAKLE[2].

SUMMARY.

The occurrence of soils belonging to the group of solonetz, or structural alkali soils, first recognised in Russia, is recorded for Western Australia.

Identified with this group are the soils of the Scaddan series, occurring in the southern portion of the Salmon Gums district. They have a sandy surface and a sandy clay subsoil, the upper part of which is divided into rounded topped columns up to one foot across.

Other soil series, viz., Circle Valley, Wallambim and Pallarup, having sandy surfaces and sandy clay subsoils, and showing several features of the solonetz profile, have also been mapped in extensive soil surveys in the mallee soil zone of Western Australia.

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Some at least of these soils have formed on Tertiary marine sediments, but other soils of the group are probably forming on other geological structures. They are low in nitrogen and exceptionally low in phosphoric acid, but well supplied with potash. The subsoil clays usually show a preponderance of replaceable magnesium but sodium may predominate and is always present in large proportions.

In all cases the development of the solonetz structure is related to conditions favouring natural leaching of the soil.

The agricultural value of solonetz soils is discussed. In the Salmon Gums district the less columnar types, for example the Circle Valley series, have proved the most satisfactory soils for cereal cultivation, but the best examples of the solonetz around Scaddan (the Scaddan series) will probably prove more valuable for pasture development than for cereals.

INTRODUCTION.

Throughout the drier regions of all the great land masses of the world occur soils which are grouped as saline and alkali soils. The saline soils contain unusually large amounts of water soluble salts when compared with the normal soils of the same or other regions, while the alkali soils, though now only low or medium with respect to salts, frequently owe some of their characteristics to the presence of excess soluble salts at an earlier stage in their development. Both types occur extensively in eastern Europe and Asia, and according to Zakharov (1927) they comprise 24 per cent. of the area of the U.S.S.R. It is not surprising, therefore, that Russian soil scientists have for a long time made intensive studies of these soils, or that the names *solonschak* and *solonetz*, used in Russia for these soils, should have been adopted by soil workers throughout the world.

WHAT IS A SOLONETZ SOIL?

Confusion over the characteristics of solonetz soils has been discussed by Kelley (1934, (b)) and Shaw and Kelley (1935). In the earlier paper Kelley put forward the view that the terms *solonschak* and *solonetz* probably originated centuries ago among the peasants of south-eastern Russia, where the term *solonetz* is used to describe the soil which contains little salt in contrast with the highly saline *solonschak.*

Field and laboratory studies were commenced by the Russians towards the end of last century, and it was first pointed out by Zemiatchensky in 1894 that the solonetz profile has a well developed columnar subsoil. The work of Gedroiz from 1912 onwards, dealing with the chemical properties of solonetz soils, emphasised the importance of exchange reactions, and particularly exchangeable sodium, in the origin and development of these soils. But while Gedroiz and his followers defined the solonetz as an alkali soil with small amounts of soluble salts and a significant proportion of sodium in the exchangeable bases, soil morphologists have tended to regard as solonetz soils all profiles exhibiting the characteristic structural features of the solonetz profile. In a review of a large volume of Russian soil literature Joffe (1931) gives the field characteristics of the solonetz profile as described by Zakharov as follows—

"0-5 cms. *A_1 horizon—light colour, no structure, loose, fine porosity.

5-10 cms. $A2_2$ horizon—lighter than A_1, foliated structure, slightly more compact.

* 1 inch equals approximately 2½ cms.

10-18 cms. B_1 horizon—dark, brown-chestnut, very compact, with cracks, columnar, the mass of which falls apart into many angular units; the columns are rounded at the top.

18-30-35 cms. B_2 horizon—slightly lighter in colour than B_1, nutty granular structure, fairly well stratified.

35 cms. + : C horizon—loess-like material with veins of soluble salts and carbonates.

The soluble salt content in the upper horizons of a solonetz is not great, at any rate, not much more than in any neighbouring normal soil."

In a more recent paper Nikiforoff (1937) discusses the morphological and chemical characteristics of the solonetz. He establishes that it is essentially an intrazonal type in the Chernosem, Chestnut and Brown soil zones, and characteristically occurs in small spots scattered through the areas occupied by the other soils.

The principal characteristics of the solonetz is the B. horizon or subsoil. This is an extremely dense and compact clay, which is very sticky and watertight when wet and which, as a result of repeated wetting and drying, has broken into angular prisms. These prisms are usually 1-3 inches across and 2-4 times as long, and frequently show rounded tops. The surface soil or A. horizon is unsaturated and typically shows a bleached (often whitish) subsurface layer. It is generally up to one foot thick and is characteristically friable. In the subsurface the structure is often finely laminated and the boundary between this layer and the subsoil is typically sharp.

Chemically, sodium and/or magnesium are dominant in the replaceable base fraction.

A number of papers from America* deal with occurrences and properties of soil showing the solonetz morphology but in several it is pointed out that only small proportions of sodium occur among the replaceable bases. In Australia, columnar clay subsoils underlying bleached subsurface horizons of light texture have been recorded from the western Wimmera of Victoria (Mullett and Rankin Scott, 1923) and in the south-east of South Australia (Taylor et al, 1933†). Prescott (1931, pp. 29 and 63) suggested that a soil type carrying redwood (*Eucalyptus oleosa* var. *transcontinentalis*) near Fitzgerald Peaks, Western Australia, had affinities with the solonetz, also soils at Swan Hill, Victoria. Recently Penman (1936) has related some of the soils of the Goulbourn Valley, Victoria, to the solonetz, and Teakle (1937 (b)) has suggested that a heavy textured soil of the Folly Flats, 20 miles south of Perth, W.A., may belong to this group.

SOLONETZ (STRUCTURAL ALKALI) SOILS IN WESTERN AUSTRALIA.

In the course of soil surveys covering over one million acres in the Lake King, Lake Brown and Salmon Gums districts of Western Australia (see map Fig. 1) several soil types have been identified which have profile characteristics similar to

* Nikiforoff (1930) (1937), Joel (1932), Storie (1933 (a) and (b)), Kelley (1934 (a) and (b)), Kellogg (1934), Isaak (1934), Nieschmidt (1934), Ellis and Caldwell (1935), Murphy and Daniel (1935), Rost (1936).

† Taylor has privately communicated the fact, not stated in C.S.I.R. Bull. 76, that the Willalooka sand and the Monkoora sand showed well-developed round-topped columns, up to 4 inches across, in their subsoils.

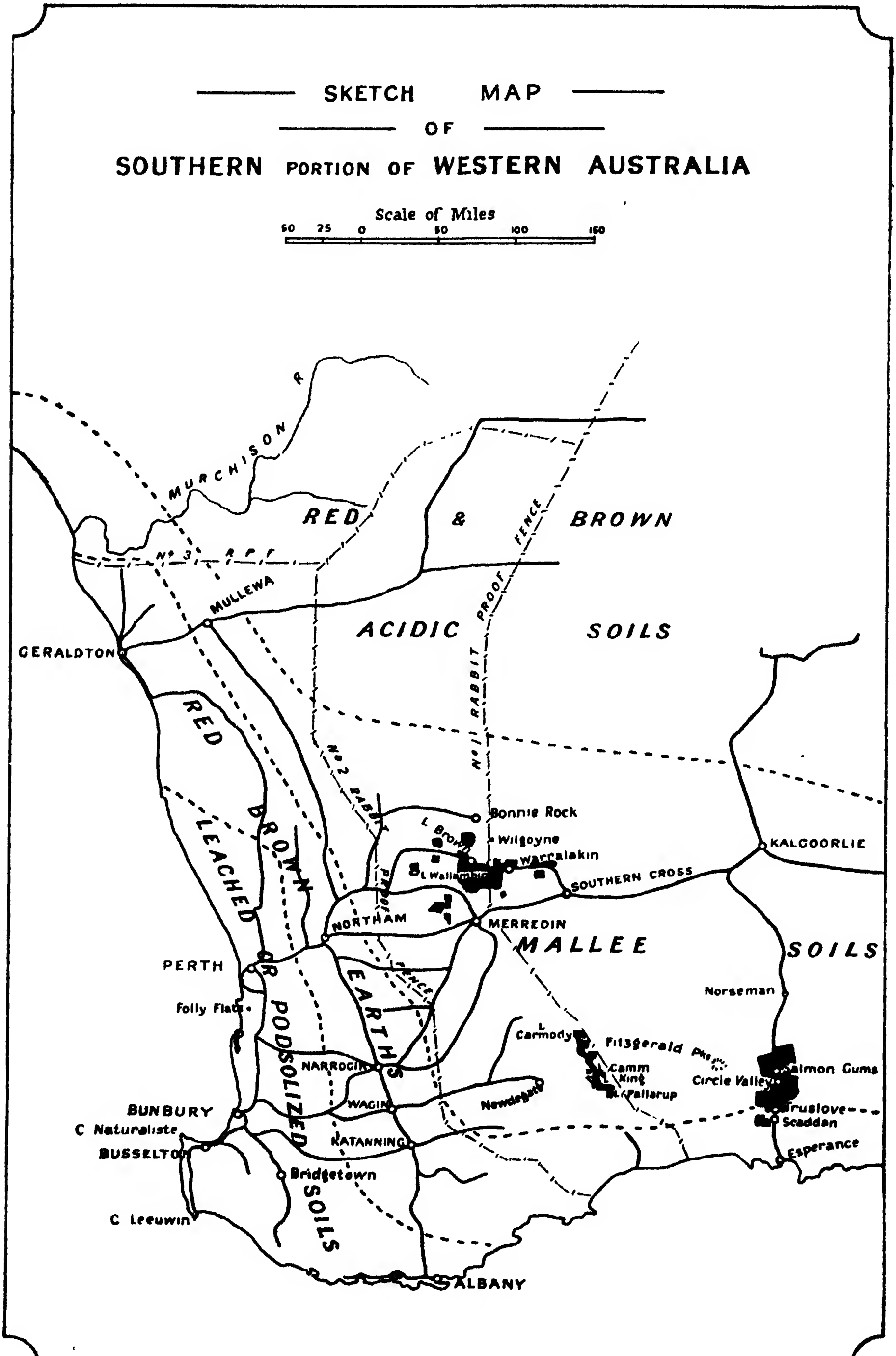

Fig. 1.—Map of the South-West portion of W.A., showing the mallee soil zone in relation to other soil zones, the location of soil surveys in which solonetz (structural alkali) soil have been recognised and mapped, and the places referred to in the text.

those of the solonetz. Their surface horizons are of sand, which is bleached in its lower portion and which passes abruptly to a tough sandy clay subsoil. Many farmers and others who have worked the greyish sandy surfaced soils of the mallee or salmon gum (*Euc. salmonophloia*) zone of the wheat belt will have noticed the irregularities of this underlying clay. Its surface is slightly irregular and lumpy in the drier areas, but under higher rainfalls (15 to 17 inches per annum) as around Truslove and Scaddan, well defined rounded topped columns 8 to 10 inches high and up to 12 inches across are to be found below the sandy surface.

The Scaddan series embraces such soils, and includes the best or most advanced examples of the columnar subsoil yet observed in Western Australia. Considering both its structure and chemical characteristics the Scaddan series is considered to be a good example of a solonetz. The nature of the columnar subsoil is illustrated by the photograph of Fig. 2 which shows the subsoil over an area of one square metre (approximately one square yard) exposed by scraping away the overlying

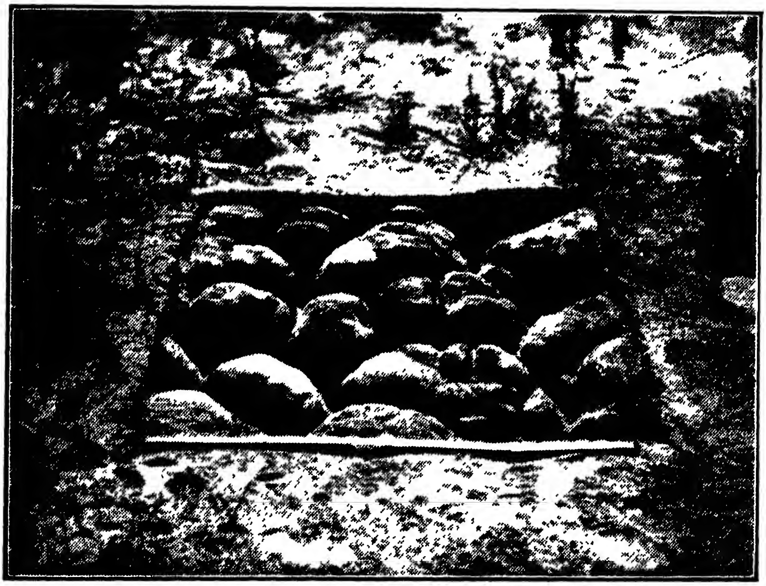

Fig. 2.—Photograph showing the tops of the soil columns after removal of the surface sand in the Scaddan series. (The measure is a yard stick.)

sand. It will be noted that individual columns are up to one foot across—a much larger size than the columns described for solonetz profiles in other parts of the world.

The Circle Valley series, whose soils have many points in common with those of the Scaddan series, also occurs extensively in the Salmon Gums district north of Truslove. In this case, the same well defined A_1, A_2 and B horizons occur as in the Scaddan series, but the sandy clay subsoil when exposed, shows only shallow grooves instead of deep, sand-filled clefts. The total area mapped of the Scaddan and Circle Valley series is 240,414 acres. A rather similar soil (Pallarup sand) has been mapped in surveys of the Lakes district, and it is known that large areas of

similar soils occur in the unsettled areas between Lake King and Salmon Gums. Another type related to the solonetz soils (Wallambin sand) occurs in the areas covered by the Lake Brown soil surveys. This soil, as well as other sandy surfaced areas between Lake King and Salmon Gums, has its vegetation association frequently dominated by redwood (*Euc. oleoso* var. *transcontinentalis*).

All the above soils occur within the zone of mallee soils (Prescott, 1931) a group which probably owes its special characteristics largely to accessions of cyclic salt, coupled with a rainfall whose leaching effect is small. The best developed solonetz profiles in Western Australia (and probably in South Australia) occur on the wetter margins of the mallee zone, where the leaching factor, especially on sandy surfaced areas, is sufficiently increased to cause the eluviation of clays containing a considerable proportion of replaceable sodium and magnesium; this process results in the development of rounded topped columns in the clay subsoil.

Rainfall data for Scaddan and Salmon Gums, Lake Brown and Lake King are given in Table 1.

THE SCADDAN SERIES.

A detailed description of a typical profile of this series is as follows:—

Horizon.	Depth. ins.	
A_1	0–1	Light grey brown sand, structureless, containing small roots.
A_2	1–2	Light grey to white sand which also fills the spaces between the rounded tops of the columns of the B_1 horizon and thus reaches to about 10 inches.
B_1	2–8	Dull yellowish and greenish-grey, hard sandy clay in irregular columns with well rounded tops (see Fig. 2). The columns are up to one foot across and have a coarse nut structure. In the upper part of each column there is some darkening due to organic matter.
B_2	8–27	Dull yellowish and greenish-grey compact sandy clay with more or less vertical pockets of whitish calcareous nodules and soft lime.
B_3	27–36	Dull yellowish and greenish-grey with faint light brown mottlings, compact sandy clay with scattered calcareous nodules. Small black specks appear in the sandy clay.
C	36–110+	Sandy clay, light brown and yellow-grey to grey and brown mottled in colour; texture becomes heavier with depth. (Similar clays under the related Circle Valley series have been found to rest on sandstone at depths of 15 to 20 feet.)

Mechanical analyses and chemical data for samples from this profile are given in Table 2, while Table 3 includes data on replaceable bases for these samples as well as for others from Western Australia profile showing characters of the solonetz. For comparison similar data for two Californian solonetzes are included (Kelley, 1934 (b)).

The natural vegetation on the Scaddan series consists of mallee and sapling Eucalypts 3 to 8 feet in height with an undergrowth of small teatrees (*Melaleuca spp.*). Common members of the vegetation are *Eucalyptus Forrestiana, E. Flocktoniae, E. dumosa, E. eremophila, Melaleuca uncinata, M. pentagona, M. cardiophylla,* and spp., *Grevillea plurijuga* and spp., *Daviesia aphylla, Exocarpus aphylla, Hakea laurina,* lamb poison (*Isotropis sp.*).

No more stunted vegetation is found on any of the soil types of the Salmon Gums district except that associated with ferruginous gravel, in which case heath may occur. Incidentally, it is noteworthy that, in this area, with increasing average annual rainfall (ranging from 11 to 16 inches) the average height of the eucalypts *decreases* from about 40 feet to 15 feet, suggesting that the increasing rainfall is insufficient compensation for changes in soil characteristics.

DISCUSSION.

The malle zone (Prescott, 1931) occupies roughly the 10 to 15 inch rainfall regions of southern Australia with mean annual temperatures mostly 60-65° F. There is a definite winter incidence of the rainfall, which is further characterised over a large part of the zone by a low average precipitation per wet day—less than 0.2 inches. Leaching and run-off under natural conditions are thus slight, and the accumulation of air-borne salts precipitated as dust and with rain is favoured. The salt (sodium chloride) content of rain water at Merredin and Salmon Gums has been determined over several years and has been discussed by one of us (Teakle, 1937). It has been shown that the accumulations of cyclic salt over a period of about 35,000 years would be sufficient to account for the salt found in the Lake Brown and Salmon Gums soils to depths of 50 feet.

Nevertheless there is geological evidence discussed by Jutson (1934) that part, if not all, the Southern portion of Western Australia was beneath the sea in Miocene times, and the soils of large areas of the mallee zone in W.A. may be developed on marine sediments of that period. In the Salmon Gums district marine sediments, of which a spicular sandstone is representative, certainly occur, and may be observed in exposures around numerous salt lakes. Borings to 15 to 20 feet in areas of the Circle Valley sand have encountered a similar sandstone and it is possible that the mottled sandy clay underlying for many feet most soil types of the Salmon Gums district is a stratum of marine origin.

On the other hand this strongly acid, mottled clay material occurs at relatively constant depths below the surface in practically all soil types and from some points of view appears to be a definite part of the soil profile. In 26 sites the average and modal depth at which this horizon was encountered was eight feet and the range three feet to 12 feet. It seems unlikely that a marine deposit would follow so closely a surface obviously modified by wind action and erosion. The virgin soils are all high in salt to great depths. (In the deep subsoils total water soluble salts figures are usually 0.5-1.25 per cent. with chloride, expressed as sodium chloride 0.4-1.0 per cent). It may be that both cyclic salt and residual salt from the Tertiary submersion have contributed to the salt now present in these soils

In other parts of the world soils with solonetz morphology appear to develop very commonly on marine and lacustrine sediments. Vilensky (1930) found alkali soils, which include the solonetz, very common on the Aralo-Caspian lowland of south eastern Russia, which represents a sea bottom of post Tertiary times. The west Siberian plains were also occupied by the sea in Tertiary times and on the salt impregnated sediments, saline and alkali soils are now found. Many of the solonetz-like areas in California are developed on marine terraces which still show stratification. They are discussed by Storie (1933 (a) and (b)), and Kelley (1934 (b)) and Nikiforoff (1937) and seem to occur under climatic conditions generally similar to those in the mallee zone of Australia, viz., 8-20 inches annual rainfall with winter incidence, 60-62° F. mean annual temperature. Nikiforoff (1930), Joel (1932), Ellis and Caldwell (1935) and Rost (1936)

describe solonetz soils developed on the lacustrine clays of the glacial Lake Agassiz which formerly covered parts of Minnesota, Saskatchewan and Manitoba. Murphy and Daniel (1935) consider the solonetz soils of Oklahama to be derived from saline marine sediments, while in Western North Dakota marine deposits are included by Kellogg (1934) among the parent materials of solonetz complexes.

From the papers of Storie and Kelley it appears that the Huerhuero fine sandy loam of southern California resembles the Scaddan sand both in general profile features and in the composition of its replaceable bases. The similarity both in amount and composition of the bases is apparent from Table 3. Leaching soil with fresh sea water has been shown by Kelley to give replaceable bases in proportions very similar to those in the subsoils of these types and he considers that such magnesium-sodium clays point to a probable marine origin.

In Australia, and, indeed in Western Australia, certain soil types with magnesium-sodium clays are undoubtedly formed on marine or lacustrine sediments of Tertiary age, but the position is by no means certain for many other such types. In many cases in Western Australia, physiographic evidence would indicate a parent material formed in situ from rocks of Precambrian age.

Columnar structure in Western Australia tends to form where the surface is a sand, which promotes absorption, downward penetration and retention of water. Adjacent types, no more than a few feet distant and at substantially the same level, but without the sandy surface are similarly saline and solonised but do not exhibit the solonetz structure. This would indicate that the development of the structure is a function of the liability of a soil type to a certain amount of leaching. Sodium salts, whether of marine or cyclic origin, are the raw materials for producing solonisation and it is difficult to believe that recent marine or lacustrine sediments are essential for the formation of solonetz or even solonised soils.

The possibility that the surface sand is a transported stratum deposited on the surface of the clay must not be overlooked. However, the subangular and rounded sand grains of the subsoil clay resemble those of the surface horizon (see next paragraph) and the ratio of fine sand to coarse sand (Table 2) is reasonably constant throughout the profile If the surface sand were a transported stratum a different fine sand: coarse sand ratio might have been expected. Hence it is concluded that the layering of sand over sandy clay in this case probably represents a true soil profile formation and not a geological stratification.

Through the courtesy of Dr. Dorothy Carroll, of the University of W.A., a mineralogical examination has been made of the samples from the Scaddan profile discussed above. The materials finer than the coarse sand fraction were examined from samples A1743-1746 and A1750. The quartz grains were found to be subangular to rounded, while the clay material was "felty" and semi-opaque and yellowish brown and pale brown in colour. The optical properties (refractive index 1.53) indicated that the clay belongs to the beidellite group of clay minerals. In the deep sample A1750 were observed a proportion of some clear brighter brown particles with refractive index just over 1.56 indicating a trend towards the nontronites in the deeper horizons.

The chemical analyses (Table 2) of the Scaddan soil show several interesting features. Total nitrogen is low throughout the profile and an extremely low phosphorus level is indicated. On the contrary, potash is very high in all the subsoil samples and reaches 0.908 per cent. (K_2O) in the B_2 horizon. The organic carbon figures indicate an accumulation of organic matter in the column tops, which,

as a result, show the darkening mentioned in the profile description. The surface sand is neutral in reaction (pH 6.92) and the column tops (pH 7.40) are less alkaline than the B_2 horizon clays containing calcium carbonate. The pH of 4.45 at 96-112 inches is similar to that at similar depths in most mallee zone profiles in W.A.

SOLONETZ SOILS IN AGRICULTURE.

Solonetz soils, generally, have features which are undesirable in good agricultural soils. Where, as in California, they are utilised under irrigation the dense clay subsoil does not allow ready penetration of water; Storie (1933 (a)) records that losses have been large in southern California where such soils have been planted with citrus and avocado. In evaluating the soils of those regions he (1933 (b)) gives the solonetz soils ratings of only 20 to 50 compared with a maximum possible rating of 100 for the best agricultural soils. In the prairie regions of U.S.A. small areas of solonetz soil occur spotted throughout the normal soils. They are particularly subject to erosion and produce the bare so-called "slick" spots when the tough intractable subsoil is exposed. Isaak (1934), Kellogg (1934) and Murphy and Daniel (1935) have studied the "slick" spots in Idaho, North Dakota and Oklahoma respectively. At Goroke, in Victoria, Mullett and Rankin Scott (1923) found that the application of 1½ tons per acre of gypsum, in addition to the usual dressing of 1 cwt per acre of superphosphate increased the yield of wheat on a solonetz soil from 15.7 to 26.5 bushels.

In Western Australia most evidence on the agricultural value of these soils is available from the Salmon Gums district, and here owing to the peculiar soil problems of the area they have proved by comparison the most satisfactory soils for cereal cultivation. Nevertheless returns have been generally better in the lower rainfall portions of the district on the Circle Valley sand than at the wetter southern extremity round Scaddan, where the well developed solonetz soils of the Scaddan series occur. With a rainfall of 16-17 inches at Scaddan it should, however, be possible to develop useful pasture grasses and even the Dwalganup strain of subterranean clover, and make cereal cropping secondary to grazing.

After clearing, sandy surfaced soils of the Circle Valley and Scaddan series are found to undergo a marked leaching of soluble salts from the upper portions of their subsoils. This has been one reason for their superiority over the heavy textured and powdery calcareous ("kopi") soils in the Salmon Gums district. The sandy surfaces also aid in moisture conservation but are subject to some wind erosion, and, if originally less than a few inches deep, the tough sandy clay subsoil may be exposed by wind action or by ploughing. If broken up by the plough the subsoil does not form a good tilth but runs together on wetting, and sets very hard on drying. Bare spots in crop or pasture usually result, and surface accumulation of salt frequently occurs at such spots.

It is significant that, on the basis of the composition of the replaceable base fraction, the soils of the "mallee" zone generally are solonised, sodium and magnesium being the most abundant bases, but the structural characters of the solonetz have not generally been developed except in certain soil series resembling those described. The non-structural soils are usually highly productive for cereals when the rainfall is adequate. Where the solonetz structure is evident, however, as in the Scaddan and related series, cultural difficulties arise but the use of soil ameliorants, such as gypsum, gives promise of alleviating the condition and raising the productivity level to that of the more favoured non-structural types.

ACKNOWLEDGMENT.

Acknowledgment is here made of the valuable assistance rendered by Professor J. A. Prescott of the Waite Institute to one of us (G.H.B.) in locating several interesting papers on solonetz occurrences. All of the literature cited was examined in the library of the Waite Agricultural Research Institute, Adelaide.

TABLE 1.

Rainfall Data for Areas in W.A. where Soils with Solonetz features occur.

Centre.	Rainfall Points.													Rain per rain day.	Records (years).
	Jan.	Feb.	Mar.	Apl.	May.	June	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Year.		
Scaddan	48	50	118	157	225	222	168	193	145	138	95	86	1,645	21·5	19
Salmon Gums	52	55	121	118	138	149	138	146	99	117	81	73	1,282	16·9	15
Lake King	55	16	136	74	159	151	192	175	101	141	36	56	1,292	16·0	7
Lake Brown	49	36	97	93	107	145	148	127	71	54	37	59	1,023	15·8	18

100 points = 1 inch.

TABLE 2.

Mechanical Analyses and Chemical Data for a Profile showing Well-developed Solonetz Structure (Scaddan Series, Truslove, W.A.).

Sample No.	1743	1744	1745	1746	1747	1748	1749	1750
Horizon	A_1–A_2	B_1	B_2	B_3		C		.
Depth (inches)	0–2	2–8	8–27	27–36	36–50	50–72	72–96	96–100
	%	%	%	%	%	%	%	%
Coarse sand	27·8	20·8	16·6	17·3	..	....	...	12·7
Fine sand	65·5	41·7	38·7	41·6	....	.	...	25·7
Silt	1·7	1·2	0·2	0·3	...	....	....	1·1
Clay	4·6	32·8	35·5	36·6	.	....	....	56·3
Loss on acid treatment	0·2	1·6	6·2	1·9	....	..	...	1·3
Moisture	0·4	3·4	4·0	3·6	...	...	..	4·6
Loss on ignition	1·6	4·6	5·7	4·0	....	....	....	7·1
Calcium carbonate	...	0·1	4·3	1·0	...	....	.	..
Total water soluble salts	0·034	0·25	0·47	0·51	0·52	0·53	0·58	0·64
Chloride (as NaCl)	0·008	0·11	0·28	0·37	0·41	0·42	0·41	0·48
Organic carbon	0·595	0·665	0·153	0·085	....	...	....	0·169
Total nitrogen (N)	0·027	0·028	0·013	0·011	...	..	...	0·011
Potash (K_2O)	0·064	0·598	0·908	0·750	....	....	...	0·787
Phosphoric acid (P_2O_5)	0·003	0·005	0·003	0·003	...	...	...	0·004
Reaction (pH) (1 : 2·5 quinhydrone)	6·92	7·40	8·55	8·35	8·04	7·60	5·47	4·45
C : N ratio	22·0	23·8	11·8	7·7	....	....		15·4
Fine sand : coarse sand ratio	2·36	2·00	2·34	2·41	..	....	....	2·02

Analyses by Government Chemical Laboratory, Perth.

TABLE 3.

Replaceable Bases of W.A. Soils, showing Solonetz features.

Soil Type.	Serial No.	Horizon.	Depths.	Clay, less than ·002 mm.	Replaceable Bases.	Percentage of Total Bases. Ca.	Mg.	K.	Na.	pH.
			ins.	%	m.e. %.*					
Scaddan sand (Truslove, W.A.)	1743	A_1A_2	0–2	4·6	2·39	61	23	11	5	6·92
	1744	B_1	2–8	32·3	18·40	21	49	6	24	7·40
	1745	B_2	8–27	35·5	19·34	18	41	8	33	8·55
	1746	B_3	27–36	36·6	18·87	13	45	9	33	8·35
	1750	C	96–110	56 3	15·01	1	52	9	38	4·45
Circle Valley sand (Salmon Gums Research Station)	.	A	0–7	...	6·45	61	24	6	9	7·81
		B_1	7–15	.	15·17	21	42	11	26	8·34
	..	B_2	15–30		19·97	10	40	15	35	8·43
Pallarup sand (Lake Camm, W.A.)	466	A_1A_2	0–6	5·0	7·21	42	41	6	11	7·55
	467	B_1	6–14	43·2	21·69	18	35	15	32	8·39
	468	B_2	14–27	39·3	22 25	15	34	17	34	8·25
	469	. .	27–43	47·2	23·83	12	33	19	36	8·09
Wallambins and (Wilgoyne, W.A.)	598	B_2	17–31	...	19·78	30	36	7	27	8·31
	600	B_3	38–48	....	15·09	26	38	9	27	8·39
Huerhuero series (Oceanside, California) (Kelley, 1934 (b))	....	A	½–10	..	10·8	59	35	3	3	7·31
	....	B_1	10–20	....	23·6	28	53	2	17	7·56
	....	B_2	20–35	..	19·6	26	51	2	21	8·96
Antioch series (Salinas, California) (Kelley, 1934 (b))	....	A	0–18	...	7·6	64	28	1	7	6·36
	..	B_1	18–24	..	20·5	41	43	0	16	7·64
	....	B_2	30–37	.	27·6	28	42	1	29	8·40

* Milli-equivalents per 100 grams of soil.

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PASTURE DEVELOPMENT.

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The Third Year's Report on the Irrigated Rotational Grazing Demonstration being conducted by the Department of Agriculture in conjunction with the Australian Dairy Council on the property of Mr A. E. Jackson, Roelands.

A resumé of the First and Second Years' operations was published in the March, 1936 and 1937 issues of this Journal.

The total area of the demonstration is 12.895 acres.

During the early part of 1936, the area of irrigated pasture was increased from the original 10 acres, and the full grazing was obtained over the whole area from 1st May, 1936.

The objects of the demonstration included—

1. The collection of information as to whether it would be more profitable to establish permanent pasture with a cover crop than to sow the permanent perennial pasture alone.
2. The collection of data regarding the carrying capacity of small irrigated areas.
3. The collection of data to show the change in composition due to rotational grazing under irrigated conditions.
4. To obtain the monthly yield of green material per acre.
5. To test the effect of varying the time between waterings during the irrigation season.

All the particulars regarding soil types, seed mixtures, fertilisers, cultivation, irrigation, cover crops for each plot were given in detail in the previous reports and are briefly as follow:—

1. Seed mixtures were sown during the 8th to 12th November, 1934.
2. The following Standard Seed Mixture was applied to all plots—

   New South Wales Paspalum dilatatum 10 lbs. per acre + New Zealand Certified White Clover, Mother Strain, 2 lbs. per acre.

The additions being as follow:—

Field 1. Standard Mixture + Sudan Grass 7 lbs. per acre.
Field 2. Standard Mixture + Italian Rye Grass 7 lbs. per acre.
Field 3. Standard Mixture + Japanese Millet 5 lbs. per acre.
Field 4. Standard Mixture + Perennial Rye Grass 7 lbs. per acre.
Field 5. Standard Mixture.

The following details give further results of the experiment for the year ending 31st December, 1937:—

Fertiliser:

The rate of application of fertiliser for the third year, 1937, was higher than that of the second year but still well below that applied during the first year. The quantity applied was 600 lbs. superphosphate in three applications. The *first application* of 150 lbs. per acre was applied on 25th January just prior to watering. The *second application* of 280 lbs. per acre was applied early in May; and the *third application* was made in August at the rate of 170 lbs. per acre.

The quantity of fertiliser applied during 1935 consisted of 904 lbs. superphosphate and 218 lbs. sulphate of ammonia per acre, whereas in 1936 374 lbs. superphosphate plus 28 lbs. sulphate of ammonia were applied.

It will be noticed from the above that no sulphate of ammonia was applied during the past season 1937.

Early in 1936, half of each field was limed at the rate of 4 cwts. of agricultural lime per acre; to date no effect from this application has been noticed.

Cultivation:

The only cultivation carried out during the season was harrowing. The first harrowing was carried out on 11th April and the second one on 28th August. The whole area was mown on 28th February and all the surplus material raked off.

Irrigation:

Irrigation was carried out on 27th January, 28th February, and 27th March, but the irrigation was altered during the 1937-38 season to determine what effect fortnightly, three-weekly, and monthly waterings would have on the yield and composition of the pastures.

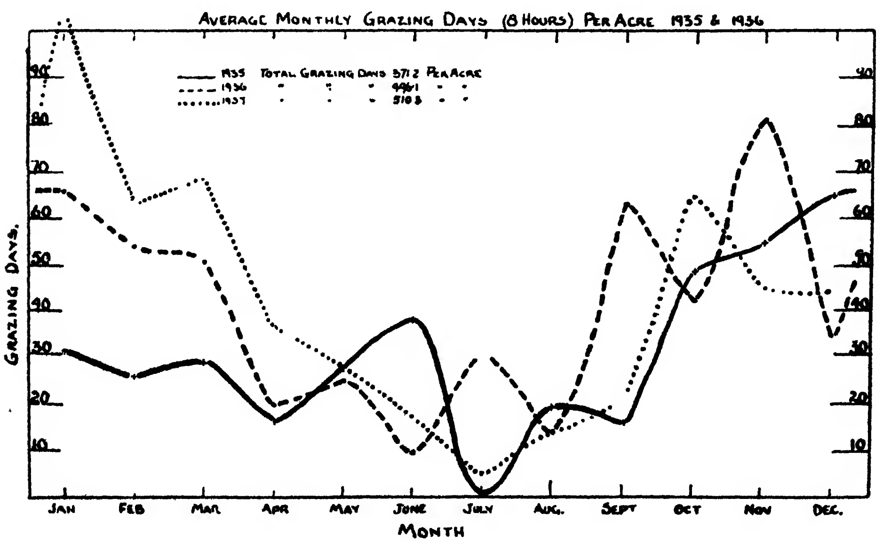
It will be seen from Table No. 1 that, at the end of 1937, with the exception of field No. 3, all the fields have given approximately the same amount of grazing for the twelve months. Consequently it was decided to apply water to two of the fields at monthly intervals, two at three-weekly intervals, and one at fortnightly intervals. The amount of water being applied per acre to each of the fields at each watering is being measured.

The following table shows the grazing days per acre which were obtained per month on each plot:—

	Field No. 1.	Field No. 2.	Field No. 3.	Field No. 4.	Field No. 5.	
January ...	133·3	98·9	104·6	118·3	82·2	107·5
February ...	56·6	80·0	60·4	58·8	56·7	62·5
March ...	32·3	70·9	59·4	62·7	113·7	67·7
April ...	21·8	17·7	29·6	36·7	67·0	34·5
May	64·6	16·8	22·2	14·2	10·6	25·4
June ...	2·0	8·7	17·5	43·1	12·5	16·8
July ...	...	...	6·8	7·1	7·3	4·2
August ...	11·8	13·7	9·6	15·5	17·2	13·6
September ...	35·0	20·7	14·6	23·2	14·6	21·6
October ...	45·2	41·3	80·0	87·3	67·5	64·3
November ...	74·3	59·2	21·8	22·6	44·9	44·6
December ...	53·0	69·4	36·6	35·5	25·3	43·9
Total ...	529·9	497·3	463·1	523·0	519·5	506·6
Average ...	44·2	41·4	38·6	43·6	43·3	42·2

From the above table it will be seen that the fields averaged approximately 42 grazing days per acre per month, and, with the exception of field No. 3 which gave 38.6 grazing days per acre per month, all the other plots averaged approximately the same amount of grazing.

The total amount of grazing obtained for all fields averaged 506.6 grazing days per acre per annum. This is slightly in excess of that obtained for the season 1936, which was 496.1, and, from the previous reports, it will be seen that 371.2 grazing days were obtained per acre for the year 1935.



The above graph shows the monthly productions for the three seasons.

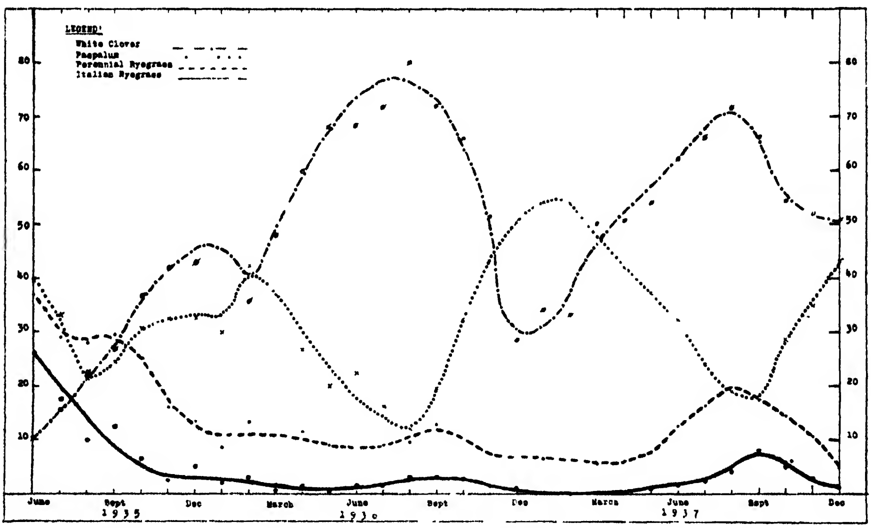
The full grazing production for the years 1935, 1936, and 1937 was as follows:—

Year.	Grazing Hours.	Total Grazing Days.	Grazing Days per Acre.	Acres per Cow.
1935	38,373	4,796·6	371·2	0·97
1936	47,019	5,877·4	496·1	0·73
1937	52,200	6,525·0	506·6	0·72

From the above it will be seen that the whole area has a high carrying capacity, and, in the season 1937, the carrying capacity was just under ¾ of an acre per cow.

Botanical Analyses.

Botanical analyses have been carried out at monthly intervals on each field from June, 1935, to December, 1937.



The above graph shows the percentage cover of perennial ryegrass for field No. 4. It will be seen from the graph that, in June, 1935, the percentage cover was 37 per cent., and, from then until December, 1935, there was a steady decline to 13 per cent; since that time it has remained fairly steady with the exception of the periods August to October of 1936 and 1937 when there was a decided increase in the percentage cover.

With the Italian ryegrass in field No. 2, the ground cover decreased from 26 per cent. in June to 5 per cent. in December, 1935. A similar increase to that of the perennial ryegrass in the months August to October, 1936-37, was noticeable, although the percentage cover for the months December to June was practically negligible.

The graph also shows that the percentage cover of Paspalum and white clover for all the fields varied considerably for the different seasons of the year. It will be noted that for the periods March to October each year the white clover is

predominant and that during the periods November to March the Paspalum is giving the bulk of the cover.

Yields per Acre.

On 10th July, 1936, three moveable quadrats which enclosed 50 sq. links were erected and set on each field, and the pasture enclosed has been cut at approximately monthly intervals from these.

The following yields were obtained per acre:—

Field No.	Period. 10th July, 1936, to 12th December, 1936.	Period. 17th July, 1937, to 15th December, 1937.
1	12·0 tons green	12·8 tons green
2	9·8 " "	14·2 " "
3	9·1 " "	13·5 " "
4	8 9 " "	13·7 " "
5	11·5 " "	14·8 " "

The production of green material per acre for the twelve months 12/12/36 to 15/12/37 was as follows:—

Field No. 1		29·1	tons per acre.
" 2	=	28·7	" "
" 3	=	29 2	" "
" 4	=	24·9	" "
" 5	=	28 5	" "

From the above it will be seen that, with the exception of field No. 4, the yield of each field was practically the same in weight of green material. It is interesting to note that no cuttings were carried out in July, as there was insufficiency of material to cut. It will be noted from the first table that there was very little grazing obtained for that month.

The following figures give the three-monthly yields for the different seasons of the year, taking spring as from September to November inclusive:—

Spring ...	6·9	tons green material per acre.
Summer ...	13·6	" " "
Autumn ...	5·7	" " "
Winter ...	1·9	" " "

From the above it will be seen that nearly half or 48.6 per cent. of the production was obtained in the summer months, December to February inclusive. Less than 7 per cent. of the total production was obtained during the winter months, showing that these three months are undoubtedly the ones where the least amount of grazing can be expected.

During the winter of 1937 further drainage was carried out to alleviate the excess moisture which ocurred on one corner of field No. 1. On this area there was a considerable growth of rushes. Control operations were carried out wherever rushes occurred on any of the fields.

Tentative Conclusions.

Results show that—

1. Rapid growing cover crops are detrimental to the initial establishment of white clover and, to a much lesser degree, Paspalum. If Couch

grass (*Cynodon dactylon*) is present prior to seeding, cover crops will definitely assist the spread of it to the detriment of the sown pastures.

2. Rapid growing cover crops cannot be recommended when establishing permanent pastures under irrigation.

3. Rates of superphosphate up to 6 cwts. per acre are profitable, and at least 4 cwts. per acre should be applied annually in two to four applications. Indications show that the heavier rates per acre should be applied in the autumn.

4. Super and ammonia mixtures are only recommended as an initial application at the time of planting; 2 cwts. per acre at least should be applied.

5. The following seed mixtures can be recommended for irrigated areas:—

(1) *Paspalum dilatatum*	10lbs.	per acre.
White Clover—Certified	2lbs.	„
(2) Perennial Rye Grass—Certified ...	4lbs.	„
Paspalum dilatatum	8lbs.	„
White Clover—Certified	2lbs.	„

As no conclusive results are yet available from the Variety Trials being conducted, the second year's report of which are recorded below, no alteration in these two mixtures is recommended.

SECOND YEAR'S RESULTS OF IRRIGATED SPECIES TRIALS UNDER CONTROLLED METHODS OF GRAZING.

The first year's results were published in the March, 1937, issue of this Journal.

J. Neil's Property, Waroona.

The area of the demonstration is 12.94 acres. This area was divided into five fields and a race, the area of the fields being as follows:—Fields Nos. 1, 2, 4, and 5, 2.39 acres each. Field No. 3, 2.5 acres.

The objects of the experiment were:—

1. To determine the most suitable plants for the establishment of permanent pastures under irrigated conditions on the soil type selected in this irrigation area.

2. The collection of data regarding the carrying capacity of these pastures on small irrigated areas.

3. To determine the actual yield per acre from the various mixtures under existing conditions.

Seed Mixtures.

Seed mixtures sown during mid-October, 1935, were as follow:—

Field No. 1. N.Z. Certified Mother Strain Perennial Rye Grass + N.Z. Certified White Clover 2 lbs. per acre.

Field No. 2. N.S.W. Handshaken *Paspalum dilatatum* 10 lbs. + N.Z. Certified White Clover 2 lbs. per acre.

Field No. 3. N.S.W. Handshaken *Paspalum dilatatum* 8 lbs. + N.Z. Certified Mother Strain Perennial Rye Grass 4 lbs. + N.Z. Certified White Clover 2 lbs. per acre.

Field No. 4. N.Z. Tall Fescue 2 lbs. + N.Z. Certified White Clover 2 lbs. per acre.

Field No. 5. Certified *Phalaris tuberosa* 4 lbs. + N.Z. Certified White Clover 2 lbs. per acre.

Fertilisers.

The total weight of superphosphate for the first year was 900 lbs. + 100 lbs. sulphate of ammonia per acre. During the past season 720 lbs. superphosphate has been applied per acre in four applications, the months being January, April, September, and December.

Cultivation.

Cultivation with the "Sunblade" pasture harrow was carried out in January and July, and on each occasion the pasture was stroked twice.

Irrigation.

The fields were irrigated at the following times during the last season:—8th January, 4th February, 24th February, 22nd March, 16th November, and 16th December.

Grazing.

The following table shows the grazing days which were obtained per month on each plot for the years 1936 and 1937.

TABLE 1.

COW GRAZING DAYS (8 HOURS) PER ACRE.

Month.	Field No. 1.		Field No 2.		Field No. 3.		Field No. 4.		Field No. 5.		Average Grazing days per acre per month.	
	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.
January	...	20·9	.	41 9	...	40·0	.	41·9	.	20·9	.	33·1
February	13·4	20·9	13·4	20·9	12·8	20·0	13·4	20·9		20·9	10·6	20·7
March		21·8		42·6	...	20·7	.	40·1	13·4	21·8	2·7	29·4
April	26·0	16·4	13·0	16·4	12·8	16·0	13·0	17·2	13·0	16·8	15·4	16·5
May	....	....	.	.	.	..	...	.	...	.		..
June	14·6	19·6	14·6	19·6	28·0	17·2	29·3	22·1	14·6	36·1	20·2	22·9
July	....	36·2	....	39·1	...	18·2	....	39·0	..	36·2		33·7
August	....	9·4	17·6	9·4	33·6	24·6	17·6	9·4	17·6	18·9	17·3	14·3
September	35·1	15·7	17·6	15·7	....	..	17·6	34·5	17·6	15·7	17·6	16·1
October	30·1	42·2	48·4	49·0	32·6	37·2	48·4	43·6	64·2	42·2	44·7	42·8
November	18·8	27·2	36·0	20·4	16·7	39·2	18·0	6·8	18·8	40·8	21·7	26·9
December	38·5	34·5	38·5	34·5	54·8	52·2	57·4	41·1	76·2	34·5	53·1	39·3
Total	176·5	264·8	199·1	310·5	191·3	285·3	214·7	316·6	235·4	304·8	203·2	296·4
Average	14·7	22·1	16·6	25·9	15·9	23·8	18·9	26·4	19·6	25·4	16·9	24·7

Carrying capacity of whole area 1936 = 1 cow to 1.80 acres.

Carrying capacity of whole area 1937 = 1 cow to 1.24 acres.

Total grazing, 1937—

28,535 grazing hours from 12.94 acres.

2366.1 grazing hours per acre.

295.7 grazing days.

From the above Table it will be seen that no grazing was obtained from all fields for May, 1936-37. The average grazing days per month for 1936 was 16.9; the figure for 1937 was 24.7, which showed a considerable increase.

The various grass species in association with white clover gave the following average grazing per month for each year 1936-1937:—

	Grazing Days per Month. 1936.	1937.
Field No. 1.—Perennial Rye Grass	14.7	22.1
„ 2.—Paspalum	16.6	25.9
„ 3.—Perennial Rye Grass and Paspalum ..	15.9	23.8
„ Tall Fescue	18.9	26.4
„ 5.—*Phalaris tuberosa*	19.6	25.4

From the above it will be seen that, although there was not much difference in the amount of grazing obtained from each field, the perennial ryegrass and perennial ryegrass-Paspalum fields have given slightly lower yields during both seasons.

Yield of Green Material per Acre.

On 13th July, 1936, three moveable quadrats which enclosed 50 sq. links were erected and set on each field, and the pasture enclosed is cut at approximately monthly intervals. After cutting, the quadrats are set on a different area of pasture from that where the material was cut.

The following yields of green material per acre were obtained for the twelve months 9/12/36 to 16/12/37:—

Field No. 1	=	20.9	tons per acre.
„ 2	=	18.4	„ „
„ 3		19.0	„ „
„ 4	=	18.6	„ „
„ 5	=	17·3	„ „

The average production of green material per acre was 18.8 tons.

From the above it will be seen that there was very little variation in the yields per acre, but field No. 1 gave the highest, and field No. 5 the lowest yield.

The yields per acre for the same periods of 1936 and 1937 were as follow:—

Field No.	Period. 13th August, 1936, to 9th December, 1936.	20th August, 1937, to 16th December, 1937.
1	6·3 tons green	12·3 tons green
2	7·3 „ „	10·4 „ „
3	6·8 „ „	11·6 „ „
4	6·3 „ „	12·4 „ „
5	6·9 „ „	10·5 „ „

The average yield per acre for the four months 1936 was 6.7 tons, whereas for the same period 1937 it was 11.0 tons or 64 per cent. more

The figures for the three monthly yields for the different seasons of the year are as follow:—

Spring ...	... 6·36	tons green material per acre.
Summer	... 6·76	,, ,, ,,
Autumn	... 3·63	,, ,, ,,
Winter	... 1·98	,, ,, ,,

The spring and winter production from this demonstration was practically the same as that obtained from the irrigated experiment on the property of Mr. A. E. Jackson, but the summer production is about half, and the autumn less than that obtained on Jackson's property. It is expected that much higher yields will be obtained this season.

General.

Very little signs of "Dodder" were observed during the season, excellent control being obtained by using the pasture harrows during the winter months of the previous season.

The more efficient drainage which was provided during the winter of 1936 brought about a reduction of the obvious surface salt during the following summer and now a full ground cover of pasture has been obtained

C. H. Henning's Property, Hamel.

Full particulars as to the type of land and method adopted for sowing and cultivation are given in the March, 1937, *Journal.*

The objects of the experiment were the same as those of J. Neil, Waroona.

An area of 10 acres was selected and divided into 5 fields, 4 of which are under permanent pasture, the size of the fields being as follows:—

Field No. 1	=	2	acres.
,, 2	=	2·06	,,
,, 3	=	1·79	,,
,, 4	=	2·39	,,
,, 5	=	1·79	,,

Irrigation.

During last season four waterings were given, the dates being 13th January, February, and March, and 1st December.

Fertiliser.

Two applications were given during the season, the first one on 30th March at the rate of 320 lbs. superphosphate per acre, and the second on 27th September at the rate of 180 lbs. superphosphate per acre, giving a total of 500 lbs. per acre for the year. The application during the first year was 4 cwts. in two applications.

Cultivation.

The only cultivation carried out during the season was by the ordinary harrows, this being done on 29th March.

Seed Mixtures.

The seed mixtures sown were as follow. In each case certified white clover at the rate of 2 lbs. per acre was applied:—

Field No. 1. N.Z. Certified Mother Strain Perennial Rye Grass 8 lbs. per acre.

Field No. 2. N.Z. Certified Akaroa Cocksfoot 10 lbs. per acre.

Field No. 3. Certified *Phalaris tuberosa* 4 lbs. per acre.

Field No. 4. N.Z. Tall Fescue 8 lbs. per acre.

Field No. 5 has not yet been sown.

Grazing.

The following table shows the grazing days per acre which were obtained per month on each field for the years 1936 and 1937:—

TABLE 2.

COW GRAZING DAYS (8 HOURS) PER ACRE.

Month.	Field No. 1.		Field No. 2.		Field No. 3.		Field No. 4.		Average Grazing Days per month.	
	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.
January .		53·0		21·1		10·4	..	24·1		27·2
February .	6·9	28·0	6·9	49·0	6·9	40·5	10·3	46·6	7·75	41·0
March ...	6·9	32·5	3·4	45·1	3·4	50·6	9·4	57·5	5·78	46·4
April ..	15·8	26·0	19·7	31·5	19·7	21·6	19·4	19·1	18·72	24·6
May . . .	11·8	47·0	7·5	38·7	3·9	48·4	11·4	46·2	8·65	45·1
June . .	.	26·0		25·0	.	27·0	...	10·9		22·2
July	.	13·0	.	.	.	7·1	..	..		5·0
August .	.	24·0	.	23·2	.	26·6	...	25·0		24·7
September .	.	24·0	....	23·4	.	20·0	....	25·0		23·1
October .	52·0	22·0	42·5	37·5	38·0	40·0	53·0	53·0	46·38	38·1
November .	79·0	62·0		56·2	66·0	50·0	151·5	37·5	74·13	51·4
December .	48·2	53·2	125·7	106·2	58·0	56·6	125·7	72·0	89·40	72·0
Total ..	220·6	410·7	205·7	457·0	195·9	398·8	381·0	416·9	250·8	420·8
Average .	18·4	34·2	17·14	38·1	16·33	33·2	31·75	34·7	20·9	35·0

Carrying capacity of whole area 1936 = 1 cow to 1.46 acres.

Carrying capacity of whole area 1937 = 1 cow to 0.84 acres.

Total grazing, 1937—

28,164 grazing hours from 8.25 acres.

3462.3 grazing hours per acre.

432.8 grazing days per acre.

From the above table it will be seen that, for 1936, no grazing was obtained for the four months June to September inclusive. In 1937 grazing was obtained each month of the year, but only 5 grazing days were obtained for the month of July. All fields are now in a condition that grazing can be carried out at any time of the year. Peak production is obtained from these plots during the months October to May inclusive.

The various grass species in association with white clover gave the average grazing per month for the twelve months of each year 1936 and 1937.

	Grazing Days per Month. 1936.	1937.
Field No. 1.—Perennial Ryegrass	18·4	34·2
„ 2.—Cocksfoot	17·1	38·1
„ 3.—*Phalaris tuberosa*	16·3	33·2
„ 4.—Tall Fescue	31·8	34·7

To date the indications are that all the fields are giving approximately the same grazing in their second season, although the Tall Fescue gave by far the most grazing during the first season.

Yields of Green Material per Acre.

As was the case on the previous experiment, moveable quadrats were erected on each plot. During the season 1937 the following yields of green material were obtained from each field:—

Field No. 1	=	32·9	tons per acre.
,, 2	=	28·2	,, ,,
,, 3	=	29·4	,, ,,
,, 4	=	31·4	,, ,,

The above show that relatively high yields per acre were obtained from the four fields, but field No. 2 gave the lightest yield of green material, although the amount of actual grazing obtained was higher than on any of the other fields. The grazing figures may tend to be on the high side, as during the winter and early spring there was a tendency on the part of the owner to over-graze the pastures.

The production of green material per acre for the same periods 1936 and 1937 is as follows:—

Field No.	Period. 13th August, 1936, to 9th December, 1936.	Period. 21st August, 1937, to 20th December, 1937.
1	12·7 tons green	17·7 tons green
2 .	11·1 ,, ,,	14·1 ,, ,,
3 .	10·6 ,, ,,	15·2 ,, ,,
4	8·1 ,, ,,	15·8 ,, ,,

It will be noted that there was a decided increase in yield of green material for this period in 1937 over that of the previous one.

The following figures give the three-monthly yields for the different seasons of the year:—

Spring ...	... 13·6	tons green material per acre.
Summer	... 11·3	,, ,, ,,
Autumn	... 5·3	,, ,, ,,
Winter	... 1·3	,, ,, ,,

Here it will be again noted that the winter production is extremely low and that the highest production took place during the spring and summer months.

General.

During the winter a considerable amount of damage was done to the white clover on all fields by the lucerne flea. "Dodder" also was observed, but the whole area was not as badly affected as in the previous season. Close grazing of pasture during the winter months of 1937 checked the development of this parasite considerably.

Acknowledgment is made to Mr. C. Giles and Mr. A. Tindale, Dairy Instructors, for collecting the bulk of the field data given in this article.

✓ "WITHER TIP" OR "SUMMER DIEBACK."

A COPPER DEFICIENCY DISEASE OF APPLE TREES.

By T. C. DUNNE.

A disease of apple trees known locally as "wither tip" or "summer dieback" has been observed in a number of orchards in Western Australia for many years. The disease occurs mainly where orchards are planted in leached soil types such as sands, or the soils supporting the karri (*Eucalyptus diversicola*) forests of the south-western portion of the State. Either old or young trees may be affected, although in many cases where light surface soils are underlain by clay layers recovery of young trees has been noted after a few years.

SYMPTOMS.

Badly diseased trees are usually characterised by a stunted bushy growth habit due to the inability to develop a leader system.

The disease usually develops on vigorously growing shoots. During November or December brown spots appear on the terminal leaves. Small necrotic areas are next noted. Leaves developed thereafter are more severely affected and eventually wither and fall. This condition is followed by the withering and death of the upper portion of the shoot where three to twelve inches of growth may be affected (Fig. 1).

Apparently the buds on the shoot below the withered portion are quite healthy. Often during March new growths are produced from the uppermost of these buds. Following on winter pruning vigorous growth is usually obtained from shoots, the tips of which were withered the previous season.

The time of appearance and the severity of the disease may be modified by the seasonal conditions and by the district wherein the trees are located. Lateral shoots which cease growth early in the season seldom become diseased.

Of the commercial varieties of apples grown in this State "Yates" is definitely the most susceptible. Very often, trees of this variety are diseased when all other trees in the orchard are healthy. Young trees of the "Granny Smith" variety are also often diseased. In more unfavourable locations the disease has been noted affecting also the "Jonathan,' "Cleopatra" and "Democrat" varieties. Where the diseased condition exists "Cox's Orange Pippin" which is grown only to a very limited extent, is usually very badly affected.

FIELD EXPERIMENTS.

A few years ago an outbreak of Black Scab (*Venturia inequalis*) was responsible for an orchard rather badly affected with "wither tip" to be frequently sprayed with Bordeaux Mixture. Following this treatment the trees made healthy growth and it was considered that the disappearance of the "wither tip" was due to the spraying.

Copper deficiency has been shown as a factor affecting the growth of citrus (5) and of Japanese plums (1) in other areas in the State. The possibility of the same factor being responsible for a blistering of the bark on "Granny Smith" trees had also been considered (2).

Responses to zinc treatments had been reported in 1936 in connection with mottle leaf of citrus (3).

Preliminary investigations were, therefore, begun to test the possibility of either a copper or zinc deficiency causing "wither tip."

A leader of "Yates" variety showing shoots affected with "wither tip."

SEASON 1936-37—

ORCHARD A—MANJIMUP.

A number of "Yates" trees about 12 years, and which were badly growing owing to the effects of the disease were selected. The following treatments were carried out:—

(a) *Soil Applications.*		
Copper sulphate	2 lb.	Applied 14th September, 1936.
Zinc sulphate	2 lb.	
(b) *Trunk Injections.*		
Copper sulphate	A. R. Salt	Injected 14th September, 1936.
Zinc sulphate	A. R. Salt	
(c) *Limb Injections.*		
Copper sulphate	Soln. 0.025% concn.	Injected 25th November, 1936.
Zinc sulphate	Soln. 0.1% concn.	

(d) *Spray Applied to Leaves.*

Bordeaux mixture	3:3:40	Applied 25th November, 1936.
Zinc-lime mixture	3:3:40	

By March 1937 the differences between trees had become quite definite. All trees receiving copper treatments had shown considerable improvement. Although necrotic areas were common in many of the terminal leaves of copper treated trees, very few withered shoots were to be found.

Zinc appeared to have no beneficial effect, and in some cases shoots on trees treated with zinc were withered more severely than those on the controls.

On the control trees a large proportion of the shoots were badly diseased.

ORCHARD B—BRIDGETOWN.

The experimental trees were of the "Granny Smith' variety about four years old. Some shoots were beginning to wither before the treatments were begun. An attempt was made by injecting solutions of other salts to determine whether substances other than those containing copper would effect improvement. The following solutions were injected:—

(a) Copper sulphate	0.01% soln.	Injected 8th March, 1937.
(b) Manganous sulphate	0.05% soln.	
(c) Nickel chloride	0.01% soln.	
(d) Cobalt chloride	0.01% soln.	
(e) Mixture of above solutions each at one quarter concentration.		

Slight injury to the leaves was obtained with the cobalt solution and a little bark injury was noted with copper.

Observation at a later date showed that the disease had been arrested on trees receiving copper, but on all other trees additional shoots had withered.

SEASON 1937-1938—

ORCHARD A—MANJIMUP.

In this orchard soil applications, trunk injections of salts, and spraying treatments with copper and zinc were continued on the same trees used the previous year. In addition copper nails driven into the trunks of trees were tried as a method of supplying copper. Solution injections were discontinued owing to the injury caused by copper sulphate solutions of a concentration greater than 0.01%.

Complete recovery as shown by healthy growth, and the absence of diseased shoots has been obtained from soil applications or from trunk injections of copper sulphate. No benefit was obtained from the similar use of zinc sulphate.

The annual growth of the trees subjected to spraying treatments were showing signs of the disease at the time spraying was done (8th December, 1937). The one Bordeaux spraying of the previous year had no apparent residual effect. Following the 1937 spraying with Bordeaux mixture healthy growth was observed, but treatment with zinc-lime spray was not beneficial.

The copper nails had no effect in preventing the occurrence of the disease. All controls were affected.

ORCHARD C—MANJIMUP.

In this orchard a number of "Granny Smith" trees had always been badly affected by "wither tip," being only three to five feet high, although planted

several years. Affected trees were treated with salts of copper, manganese and zinc by means of soil applications, trunk injections and sprays. Copper nails were also used.

Except where the copper nails were used, all trees receiving copper were free from the disease during the first season. Withered shoots were observed on all other experimental trees including the controls.

Affected shoots before spraying,
7/12/37.

ORCHARD B—BRIDGETOWN.

In view of the satisfactory results with copper an attempt was made to induce recovery in shoots where the symptoms showed the disease to be in an advanced stage. The trees selected were of the "Yates" variety about 15 years old. Most of the shoots had not begun to wither although the young leaves were practically dead.

The trees were sprayed in early December with Bordeaux mixture and as a control with zinc-lime mixture. By the third week in January new healthy growth had been produced on the Bordeaux sprayed trees. No new growth was to be seen either on trees receiving zinc-lime spray, or on untreated trees where the shoots were badly withered.

The response to the copper treatment is shown in Figs. 2 and 3.

OTHER ORCHARDS.

Trials of a similar nature to those reported above have been conducted in other orchards. In some cases owing to the effect of seasonal conditions the controls have not been sufficiently diseased to allow of satisfactory comparisons, otherwise the results have been in accordance with those already reported. In no instance have copper treated trees been badly diseased.

ANALYSES OF LEAVES.

Copper determinations have been conducted on leaves collected from various orchards. In all cases leaves were taken from near the growing points of shoots, the uppermost four leaves being collected.

The figures obtained are given in the following tables:—

TABLE 1.

VARIETY—"GRANNY SMITH."

	Copper p.p.m. on dry basis.
Orchard "B."	
Leaves from affected shoots—disease not severe	3
Leaves from non-affected shoots—same trees as above ..	4
Leaves from non-affected shoots—healthy re-grafts on old butts	5
Orchard "Z."	
Leaves from healthy trees—clay subsoil	12

TABLE 2.

VARIETY—"YATES."

	Copper p.p.m. on dry basis. Collected Apr. 1937.	Collected Dec. 1937.
Orchard "A."		
Leaves from affected shoots—control (a)	2	3.0
Leaves from affected shoots—control (b)	..	3.6
Leaves from shoots showing response to soil treatment with CuSO4	3	4.0
Leaves from shoots showing response to trunk injections with CuSO4	..	6.2
Orchard "X."		
Leaves from healthy trees—heavy soil	8	..
Orchard "Y."		
Leaves from healthy trees—medium soil	..	5.5

TABLE 3.

VARIETY—"GRANNY SMITH."

	Copper p.p.m. on dry basis.
Orchard "C."	
Leaves from tree 426a showing response to soil treatment with copper sulphate	5.1
Leaves from tree 426b showing response to trunk injection with copper sulphate	3.2
Leaves from control tree 427b—badly affected	1
Leaves from tree 431a showing response to soil treatment with copper sulphate	2.3
Leaves from control tree 432c—badly affected	1.2

DISCUSSION.

In 1928, Smith and Thomas briefly reported a disease of apple trees apparently similar to that described in this paper. It was stated that a response to soil application of copper sulphate had been noted (4).

In the field experiments reported in this paper definite response to treatments involving the use of copper sulphate was obtained. No benefit was produced by the use of other sulphates or by compounds of zinc, manganese, cobalt or nickel. The results indicated that diseased trees were suffering from an insufficiency of copper for normal growth.

Shoots after spraying, 20/1/38. Note bare stems whence affected leaves have fallen.

The analyses of leaf materials taken in conjunction with the above results warrant the conclusion that a copper deficiency was operative. Young leaves from diseased shoots were found to have a consistently lower copper content than more normal leaves. Where recovery was noted an increase in the copper content of the leaves as compared with affected controls was observed.

It is considered that differences to be noted in Table 2 between the copper contents of leaves collected from the same trees in following seasons is due to the earlier time of sampling in the 1937-38 season.

From the point of view of disease control it should be noted that in the case of older trees neither the soil applications nor the trunk injections of copper sulphate carried out in the early spring effected complete recovery the following growing season. It is possible recovery might have been obtained by the use of large quantities of material, but injury may have resulted. Applying Bordeaux mixture to the leaves produced immediate responses during the season of application, but no residual effect was observed the following season. With young or small trees all copper treatments gave very early responses.

It is suggested that where older trees are to be treated both soil and spraying treatments with copper be carried out the first year in order to ensure healthy growth. Thereafter soil applications of copper sulphate should prevent further occurrence of the disease.

The investigation has not been carried on over a sufficiently long period for information to be available concerning the quantities of copper sulphate or the frequency of applications needed for healthy growth.

It should be noted that the apple spraying programme practised in this State does not include the use of Bordeaux mixture. Had programmes similar to those used in countries where Apple Scab is established been in operation, it is unlikely that the "wither tip" disease would have occurred.

SUMMARY.

A disease of apple trees locally known as "wither tip" or "summer dieback" has been described.

Field experiments have been reported wherein treatments of affected trees with copper sulphate by means of soil applications, tree injections and sprays have given response.

No benefit was obtained from the use of other sulphates or from compounds of zinc, manganese, nickel and cobalt.

Copper analyses of leaves from affected and non-affected shoots showed a consistently lower copper content in affected leaves.

It was concluded that the disease is due to a lack of sufficient copper for the normal growth of trees.

Acknowledgment is made of the help of Mr. B. L. Southern, of the Government Chemical Branch, by whom all the copper analyses were conducted.

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AGRICULTURAL PROBLEMS.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and name of Advisers are as follows:—

Albany	H. R. Powell
Bridgetown	A. Flintoff.
Bunbury	M. Cullity.
Geraldton	N. Davenport (Government Buildings)
Gosnells	R. C. Owen.
Harvey	R. L. Cailes (Fruit) ; A. M. Tindale (Dairying).
Katanning	A. S. Wild
Kalamunda-Roleystone	W. H. Read, c/o. Department of Agriculture, Perth.
Kununoppin	W. M. Nunn.
Metropolitan, Gingin, Chittering ...	S. E. Bennett, c/o. Department of Agriculture, Perth.
Mundaring	V. Cahill.
Narrogin	A. T. Gulvin.
Vasse	J M. Nelson.

ALL-AUSTRALIAN EXPORT BACONER AND PORKER COMPETITIONS.

Entry forms in connection with the second series of these competitions being conducted by the Australian Meat Board are required to be lodged with the works managements on or before the 15th April next, and entries should be forwarded to works in time for them to be treated and shipped so as to arrive in London for judging on 15th July. Pig producers are reminded that such competitions provide important publicity for Australian pigmeats in the United Kingdom and that the reports of the judges on individual entries are a valuable index to the producers concerned of their achievement and a guide to the type required in the United Kingdom market.

The conditions are as follow:—

Each entry should comprise three pig carcases, including heads, bred and fattened by the entrant.

Only one entry of each particular breed or cross will be allowed from each entrant. The sire of the entry must be pure-bred and from a litter recorded by the Australian Stud Pigbreeders' Society.

Weights for baconer carcases should be not less than 120 lb. nor more than 160 lb. dressed and including heads. Weights for porker carcases should be not less than 60 lb. nor more than 90 lb. dressed and including heads.

Prize money totalling £25 is awarded by the Board to successful entrants and in addition a trophy valued at £10 10s. is competed for.

No entry fee is charged.

Entry forms are obtainable from the usual trade channels, and also on application to the Veterinary Officers of the Department of Commerce in each State, and from the office of the Australian Meat Board, at 419 Collins Street, Melbourne.

WESTERN AUSTRALIA—DEPARTMENT OF AGRICULTURE.

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ERRATUM.

Journal of Agriculture, March, 1938.

"Hatch Your Chickens at the Right Time."

P. 17, para. 6, line 2: It is obvious that "4/- per bird" should read "5/- per bird," but a line was omitted which was intended to express that in order to give a greater strength to the discussion, a basis of only 4/- per bird would be taken.

"The Occurrence of Solonetz (Structural Alkali) Soils in Western Australia."

P. 99, para. 6, line 11: "Teakle (1937b)" should read "Teakle and Southern (1937)."

P. 109: Between lines 6 and 7 insert "Teakle and Southern."

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RABBITO OR SURFACE TAINT IN BUTTER.

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D. G. Griffin, Bacteriologist, South-West Co-operative Dairy Farmers, Ltd.

For several years a butter defect has been present spasmodically in West Australian butters which has puzzled those who have been in a position to know the conditions operating in the factories producing the affected butters.

DESCRIPTION OF DEFECT.

The defect is a definite type of deterioration and has now been shown to be similar to other defects in butter throughout the world, known under various names. In Eastern Australia it is usually known as "rabbito" or as "decomposed odor." Why the name "rabbito" should be selected for the defect is not obvious. In U.S. America and in Europe a common name is "surface taint."

The defect is one in which the aroma and flavour suggests a breakdown of the protein, and so putrefaction, and appears to indicate extremely unclean conditions during manufacture. It first makes its appearance at the surface and then gradually penetrates to the centre. The defect is apparently unrelated to the cream and develops only after the butter is made. At high holding temperatures its development may be rapid while at cold temperatures it may not become apparent until the butter is brought into warmer conditions. It usually becomes obvious in the butter retail trade where the holding temperatures are variable and high.

An offensive aroma on the surface usually is the first indication of the trouble. A peculiar sweetish flavour somewhat resembling that of condensed milk is sometimes noticed. The aroma quickly accentuates. A freshly cut surface may not show the aroma but it usually develops if held for a short period, even overnight. After holding the butter at the higher temperatures for some time the odor seems to disappear, but by this time the flavour of the butter is such as to render it very unpalatable.

OCCURRENCE.

The first reference to surface taint butter as such was in Western Canada in 1919. Since then it has been reported from several other parts of the Dominion. It has been described as Limburger flavour in the United States, as a putrid flav-

our in Denmark, as a foetid odor in New Zealand and as decomposed odor and rabbito in Australia.

It occurs in butter made from the choicest creams as well as in those made from inferior creams, in butter manufactured in well kept factories as well as in that made in those not so well kept. It sometimes occurs in one churning and is absent from a number of succeeding ones. It may occur in butter made in one churn and not in another for a period and then without apparent reason or change in procedure the trouble will appear in the butter made in the second churn more frequently than in that from the first. Pasteurisation of cream has been demonstrated repeatedly to have been carried out efficiently prior to its appearance. Summer conditions appear more favourable to its appearance although it has been encountered at all seasons.

HISTORICAL.

This defect was for a long period attributed to the working of the organism *Bacillus fluorescens liquifaciens.* In 1899 *Gilruth* in New Zealand drew attention to the possibility of butter which had been of first-class quality before export being "uneatable" soon after its arrival in London. He demonstrated the production of a "foetid odor" in butter by inoculating into samples B fluorescens liquifaciens which he had isolated from water. The odor appeared in butter in 36 hours when held at 65 deg. F.; in 3 days when held in a cold room at about 45 deg. F.; while further samples held at 32 deg. F. for a month did not show the defect but then developed the odor in 2 days when kept at a temperature more favourable for bacterial growth.

In 1900 an outbreak of "putrid" butter in Iowa was investigated by *Eccles.* This butter was quite unfit for table use, having a strong disagreeable taste and a "putrid" smell. Small samples of this butter inoculated into quantities of sterile milk were responsible for the production of a similar smell in the milk but much stronger. Two organisms capable of causing the "putrid" condition in butter were isolated, the less objectionable one being *B. fluorescens liquifaciens.* The second organism was not definitely identified. The creamery troubled with this defect was advised to overhaul the whole of its plant and methods, to reject any raw material giving any suggestion of the "putrid" condition, to sterilize the whole of the plant, to pasteurise the skim-milk before returning it to the suppliers, and to use a large quantity of butter starter. During this period an extended dry spell had been experienced and dust storms were comparatively frequent. At about the same time as the suggestions were made the drought broke, bringing heavy rains. The trouble disappeared and there is little evidence to show whether any or all of the factors mentioned were responsible for the trouble.

Marker apparently was the first to suggest the term surface flavour for this defect as it first becomes noticeable at the surface of the butter. He suggested that the conditions in butter which were suitable for the development of surface taint were bound up with the neutralisation of the cream.

Sadler and Vollum in their investigations in Canada with surface taint butter were able to note the conditions at the plants producing the butter. It was obvious that contamination was possible following pasteurisation. The water supplies for washing the butter were not satisfactory, while it was also shown that micro organisms of the Escherichia-Aerobacter type were reaching the butter during packing. Organisms isolated during the investigation were used in experimental churnings by Sadler and Cameron. A spore forming milk digesting micro organism in combination with one of the Escherichia-Aerobacter type caused a condi-

tion resembling surface taint when used in cream neutralised to between .10 and .21 per cent. but failed to do so when the cream was churned with a higher acidity (above .3 per cent.).

Cordes and Macy reported that surface taint butter contained large numbers of bacteria and yeasts. Macy inclined to the view that a large coccus form in association with yeasts were responsible for the trouble.

Hood and White of Canada studied surface taint butter and reported that during the years 1926-7 all butters analysed contained large numbers of bacteria capable of decomposing curd, while the total bacteria and yeast content was abnormally high. Routine examinations of butter from creameries affected with the trouble usually showed high counts but several low counts were also made. They concluded that this indicated inefficient sanitary control. They also showed that many samples of butter from unpasteurised cream contained fewer bacteria than surface taint butter.

Trials were made by inoculating various organisms isolated from well water into pasteurised neutralised cream and then churning the cream. In some cases the defect was apparent in as short a period as two days. A number of liquefying organisms were shown to be present in the water supplies of the creameries visited.

Shutt concluded that impure water supplies were responsible for the occurrence of surface taint. He indicated that city creameries were free of the trouble, having pure water supplies, and that it was a common defect in butter from rural creameries, particularly following prolonged periods of wet weather. The principal organism present in contaminated water was *Ps fluorescens*, with many other putrefactive bacteria. He showed that surface taint could be produced by inoculating *Ps fluorescens* into sterile butter and holding it at 25deg. C. for 28 days.

The following suggestions were made for controlling the defect:—

1. Substitution of pure water for contaminated water for butter making. In rural areas this meant the sinking of new deep wells.
2. Where municipal water supplies were involved or where contaminated water from other sources had to be used it was suggested that the water be heated to a temperature of 190deg. F. for 10 minutes and cooled before washing the butter.
3. Cream be neutralised to .35 per cent. acid instead of the .25 per cent. acid. This applied to cases where it was impossible to safeguard the quality of the water as indicated in 1 and 2 above.

Rumment showed that the *B. fluorescens liquifaciens* will grow freely in sweet butter (p.h. 6.8). He also stated that the free fatty acids formed by its attacking the fat have a destructive effect on the organism.

Brown, of New South Wales, reported his investigations of a defect of butter in that State referred to as a "disagreeable aroma." There seems little doubt that this is a similar defect to surface taint. Evidence was claimed to show that insanitary conditions in factories such as recontaminating foci in churns, workers and other wooden utensils, and the bacterial action in the butter brought about by this contamination was at least partly responsible for the aroma. It was concluded that the alteration in curdy material causing the aroma commenced before the butter was churned, in the putrescent curdy material which exudes from the glands of storage vats and churns, and from the crevices in churns and workers, etc. This curdy material becomes thoroughly incorporated in the butter during manufacture and there was considered to continue its breakdown, by the action of enzymes and bacterial products, producing the characteristic odor of decomposition. This

view was supported by the fact that in the examination of many samples of the bad butter putrefactive bacteria were not present in sufficient numbers to cause trouble. It was reported that when the wooden surfaces with which the cream and butter come in contact were thoroughly cleansed the defect disappeared. Particular attention was paid to any fat-saturated surfaces and in some cases it was necessary to replace articles of equipment which had been allowed to get into this condition.

The mode of occurrence of the defect was consistent with the conditions as occurred elsewhere; *e.g.*, its occurrence was spasmodic both in relation to time and district. It occurred in one churning and not in another even from the same vat.

Derby and Hammer undertook an investigation with the object of studying (a) the cause of surface taint, (b) the factors influencing its development. They stated that surface taint could not be developed by inoculating a normal product either salted or unsalted with surface taint butter, but could be developed by inoculating the defective butter into pasteurised cream and churning the cream. From 2-4 days was necessary to develop the taint.

In most cases surface taint butter was unsalted or had a low salt content and was held at temperatures very favourable to bacterial growth.

It was also ascertained that the predominating organisms obtained on plates prepared from affected butter would not produce surface taint when inoculated into pasteurised cream and the cream churned.

They were successful in isolating an organism which they believed was an undescribed species, which was capable of producing surface taint when inoculated cream was churned. They called this *Achromobacter putrifaciens.* This organism was isolated from many samples but could not be regularly secured from all. Other organisms capable of producing the taint were also secured. These organisms were always present in small numbers.

The organisms which would produce surface taint were greatly restrained by the use of medium salt percentages and/or butter culture in the making of butter.

In trials carried out with *Ps fluorescens* rancidity regularly and rapidly developed.

The change in the butter did not resemble surface taint after one day.

Comment was made on the variations of surface taint in the various samples forwarded for examination.

In South Australia *Lock* stated that rabbito would develop during warm weather, in flush periods when insufficient time is allowed for cleaning, after heavy showers late in the season, when lumpy cream was not thoroughly mixed prior to pasteurising, and in badly worked butters. Where the water supply was exceptionally bad, it would develop at any time other than in very cold weather. The degree of rabbito was said to vary with the amount of contamination, the curd content, the temperature and the method of working. Prevention was suggested by the control of water, attention to correct acidities and moderate but efficient temperatures of pasteurisation, the heat treatment of all equipment immediately before the cream comes in contact with the surfaces thereof, the thorough cleansing of churns and the thorough working of the butter. *Pseudomonas fluorescens* was referred to as an organism frequently found in water and considered a possible cause of rabbito butter.

In Victoria, *Loftus Hills, Scharp and Searle* investigated the defect. They concluded that—

1. No particular district seemed to favour the defect.
2. The defect is essentially a summer one.
3. The bacterial counts of rabbito butters are extremely high.

4. The defect requires time to develop, usually 2-4 days after manufacture being required to show its characteristics.
5. Rabbito butter worked into (1) unsalted sterile butter, (2) sterile butter 1 per cent. salt, (3) sterile butter 2 per cent. salt, caused the development of its characteristics in the inoculated samples.
6. High salt, *e.g.* 3 per cent. and high acid in the cream, over .2 per cent., greatly slowed up the change.
7. A culture of micro-organisms isolated from rabbito butter worked into sterile butter caused the typical development.
8. The bacteria were included in factory butter during manufacture due to ineffective methods of bacterial control, *i.e.* faulty pasteurisation and subsequent contamination.
9. Control consists of efficient pasteurisation and the minimum of recontamination after pasteurisation.
10. The origin of the organisms was not located, but churns were considered the most likely source. The instance of the defect disappearing when a contaminated churn was replaced with a new one was given.

A warning that other sources of infection such as the water supply storage tanks, cream vats, etc., could be causing the trouble was given.

A later report indicated that rabbito organisms had been isolated from factory water supplies, churns, raw cream and pasteurised cream. It was considered likely that the natural habitat was water. The organisms were shown to be similar to those isolated by Hammer and others in Iowa, U.S.A., from surface taint butter and to be capable of producing identical characteristics in inoculated butter. The possibility of poor texture in butter rendering it more prone to development of the defect was made, the comparatively less thorough distribution of the moisture droplets being suggested as the reason.

In Western Australia for several years there have been spasmodic outbreaks of deterioration which appeared akin to rabbito or surface taint. Our first record is the report of the then Dairy Expert, Mr. P. G. Hampshire, on his investigation into an outbreak of "stinking butter" in 1927. He pointed to inefficient grading, neutralisation and pasteurisation and to the quality of the wash water as being contributing factors. His reference to the quality of the butter wash water is interesting: "Samples taken at the tank and at the churn showed the presence of coliform bacteria which would develop trouble in the butter after manufacture and undo the work of efficient grading and pasteurisation, there being present in the water at the top of the tank 200 organisms per c.c. The water at the churn showed 2,000 organisms per c.c. with coliform organisms present."

The presence of many spore-forming bacteria in the butter was interpreted as indicating faulty grading, while a large number of coliform organisms in the vat after pasteurisation was said to indicate faulty pasteurisation.

In 1931-2 Miss E. A. Newton, bacteriologist for the Westralian Farmers, Ltd., Pascomi, Perth, carried out a number of routine examinations of butter and rinse waters. Some very high counts were recorded both from butters and from the factory equipment. She referred to a spore-forming organism which occurred in the butter samples and in samples from various points in the plant. It was suggested that this organism was possibly responsible for the poor quality of the butter.

In 1934 another bad outbreak occurred at the same factory and after a careful checking of all plant and methods, bacteriological examination indicated undue contamination taking place on the cooler.

The details of this examination indicated efficient pasteurisation but heavy contamination occurring immediately after.

	Total Organisms. per c.c.	B. Coli.
Cream before pasteurising	Millions	Present in 1/10
" after pasteurising	600	*Nil*
" at one end of water cooler * ...	1,500	*Nil*
" in holding vat	Uncountable	
Buttermilk	Uncountable	
Butter	88,000	

* Not from the mixed cream in the tray below the cooler.

Further investigation of this point led to the discovery of a hollow flange which was full of particularly offensive decomposed cream. When this was cleaned up the outbreak of stinking butter stopped.

RECENT INVESTIGATIONS.

In 1935 there was a recurrence of the same type of trouble. Following on a few churnings being reported as affected, hand churnings of cream taken from the pipe leading to the churns were carried out each morning for one month. One sample was held from each bulk churning. During this period three consignments were reported as bad. The three samples from these consignments held in the laboratory were also bad, while the samples churned in the metal hand churn from the same cream showed no defect. This indicated churn contamination and was confirmed by a test in the factory. It was noticed that the defect appeared regularly in butter made from one churn only. The churn was put out of commission for two weeks and during that period no defect was noticed in the butter. The churn was again put into commission and the first churning developed the trouble. As the barrel was old it was decided to replace it.

This was done and the trouble disappeared until early in 1936 when the defect was again observed, but on this occasion the source of the trouble was more difficult to locate. It would appear in butter made from one churn and not in that made in the other; then for no apparent reason the trouble would appear in buttter from the second churn and not from the first. No consistent evidence was available pointing to any one holding vat or any other part of the equipment.

Bacteriological surveys of the plant carried out at that time indicated that pasteurisation was regularly efficient but also that a certain amount of contamination was occurring after, and most of all in the churns. The table hereunder shows the results of two surveys made immediately before and after the plant had been closed down for a week for a thorough overhaul.

	Before Overhaul.		After Overhaul.	
	Total.	Coli/c.c.	Total.	Coli/c.c.
Main Water before use	60	—	30	—
" in Tipping Vat	600	+	200	—
" in Neutralising Vat	850	+	1,250	—
" after Pasteurising	40	—	100	—
" after Cooling	250	—	22	—
" Entrance Vat	500	—		
" from Vat 2 (next morning) ...	450	—	100	
" from Vat 3 " " ...	500	—		
" from Vat 2 to Churn 1 ...	400	—		
" from Vat 3 to Churn 2 ...	1,750	—	80	—
" from Churn 1	20,000	Uncountable	1,000	300
" from Churn 2	45,000	150	1,000	20

Eventually it was noticed that it was the butter which was made from the last portion of cream left in a vat which most frequently developed the taint. This cream was as a matter of routine washed from the vat to the churn with a certain

amount of rinse water. This naturally focused attention on the purity of the water supply and although the number of organisms present at that time was not considered excessive it was decided to treat the water. This was effected by using certain chlorine preparations. For a time relief was again experienced and then on a further outbreak it was found that the chlorine treatment was not regularly effective. For a short time the use of boiled water was tried. However, the seasonal increase in cream supplies rendered the further use of a vat for the purpose of cooling this water impossible and reliance had to be again placed on the water steriliser which was believed not to be fully effective. A short while after the above it was suggested that the cause in other places of a butter defect similar to that under discussion had been shown to be due to casein digesting organisms. A number of isolations were made of organisms from agar plates with the addition of a small quantity of sterile dried buttermilk and experimental churnings with inoculated cream were carried out. The resulting butters, though showing high counts showed no similarity to the typical condition.

Spasmodic occurrences of the defect eventually brought the decision to put down a private bore. This was done and only a few churnings have since been affected. These being within a short period of the change over of the water supply, it appears reasonable to assume that the causative organisms if water borne would then still be present in the factory pipe lines and possibly in churns, etc. However, for 12 months now there has not been a recurrence at this factory.

Owing to the frequency with which the defect became noticeable over a period of years, considerable attention was given about this time to the possibility of locating the causative organism and the conditions under which it became operative. The work commenced with a detailed visual and bacteriological examination of the plant, but with no pertinent results. Samples of affected butter were obtained for examination. Counts made on these samples usually gave very high results, but occasionally a bad sample would show a lower count than good butter made in another churning from the same vat of cream. Counts made on gelatine were without exception higher than those made on agar. Isolations were made of a number of organisms from these plates and cultures were used for inoculating pasteurised cream before churning in a small hand churn. Among these was a spore-forming organism which occurred regularly in the affected butter. Churnings made with cream inoculated with these organisms and with various materials from around the factory which were considered as possible sources such as the curdy material from the roller glands in churns, dust from ceilings, contaminated water from various places, were generally unsuccessful. However, a variety of defects were produced, demonstrating the presence of undesirable organisms in the butter or around the factory. Attention was then given also to the possibility of locating the bacteria from the factory plant or from the wash water. Some failures were experienced through the cultures being short lived. This proved the case with one particular organism isolated regularly from the water supply and which in sterile butter plates gave an odour resembling surface taint. This culture was always short lived. This suggested the possibility of the causative organism not being persistent in the altered conditions brought about in the butter. Owing to the published references to the effects of *B. fluorescens liquifaciens* and of Hammer's bacteria particular attention was paid to the possible occurrence of these types and eventually organisms similar to the latter were isolated from two water supplies. There appears to be some variation in types in these organisms particularly in the speed of their gelatine liquefication. Experimental churnings with those cultures exhibited a similar condition to the typical defect. As a matter of routine hot bottle tests were made daily of the butter made in this factory and

on three occasions only did the characteristic aroma become noticeable. One of these churnings was reported bad by the retailers and on no other occasion were complaints received while these tests were being carried out.

Regular butter analyses for salt, fat, curd and moisture were also carried out during this period. These showed no significant results. Curd was frequently a little high, averaging 1.2 per cent. An alteration in churning methods with the use of break water brought the percentage to .8-.9 per cent. The butter showed on an average 1.5 per cent. salt and the cream at churning contained approximately .15 per cent. acid. Certain butters from another factory at this time showed salt percentages regularly as low as 1.2 per cent. and 1.3 per cent. Attention was drawn to the inhibiting effect of salt and curd as reported by Hammer, Loftus Hills and others, and it was suggested that the salt percentage be increased to 1.75 per cent. and that .2 per cent. acid be left in the cream at churning. This was a temporary measure to lessen the incidence of the trouble at the time. That no further trouble occurred following this instruction does not necessarily infer that the move was effective as other factors were operating. The season was changing from summer to autumn with its cooler temperatures and there was an increase in the quantity of butter being manufactured. Further, there had been an alteration in the water supply at the principal factory, which now was obtaining its supplies from a private bore.

The water supply at one factory from which the organism was isolated was known to be poor and that it was necessary to take some steps to improve it. Arrangements have been made to sink a private bore and the results will be awaited with interest, although it is several months since any trouble has been experienced there. In this factory also during a period when the defect was appearing, a very serious focus of contamination was discovered in a water pipe line where an accumulation of stale cream was available as a food reservoir for any harmful bacteria which might have been present in the cream or in the water.

In another factory, two churnings were found to be affected recently and although there had been reason to suspect insanitary conditions some weeks prior, surveys had shown the equipment to be in reasonable condition a few days before the outbreak. On investigation it was found that there was a strong possibility of the water supply being contaminated at that time. In this case water is drawn from a town scheme. The town reservoir tanks at one time were cleansed regularly every few weeks, but for some reason this cleansing was overlooked for about a year. It transpired that the delayed cleaning took place the day before the first case of bad butter was made. No further trouble has been experienced.

In one other factory an organism has been isolated from the wash water similar to that referred to earlier and there appears little doubt that it is the causative organism either alone or in combination with other organisms or certain conditions.

At this factory where consistent trouble was experienced for a fortnight, attention was given to the manufacture of the butter in order to be sure that moisture incorporation was thorough. This was done because of an incident in the manufacture of what resulted in the first case experienced at this factory. Owing to a breakdown in the wash water supply a churning was left standing at the grain stage for some time and eventually resulted in a greasy, fairly moist butter. This butter was considered unfit for sale in its then condition and it was decided to rework it by adding a few boxes at a time to succeeding churnings. This procedure was carried out and the butter from each of the churnings

so treated fell rapidly in quality. The incident was brought forcibly to memory when the sequence of bad reports was received. But when the bad reports continued after the original churning had been disposed of, other possibilities were considered. The possibility of the faulty texture contributing to the trouble was accepted and instructions were given to the buttermakers to be particularly careful in seeing that each churning was thoroughly worked. Later, in going through this factory's records it was seen that in approximately 70 per cent. of the cases, the butter had had only one working. That is, when the butter was worked dry and the first moisture test taken, it was found that no additional water was required to bring the quantity up to requirements. The butter was then removed from the churn with no further working (it being the busy season).

A further interesting point also arose from an examination of the records. In addition to the 70 per cent. rabbito butters among those receiving only one working, there was an additional 20 per cent. of these butters which were packed specially for the metropolitan retail trade and were to be cut by a special Benhill automatic machine. Butters going through this machine need thorough incorporation of moisture, otherwise appreciable loss occurs in the process of cutting. It appears reasonable to assume, and this assumption is supported by the manager of the factory, that this butter would receive special working as the buttermakers knew of its destination because of the type of box into which it was to be packed. In those cases where the moisture was low the second working apparently distributed the bulk of the water in much finer condition. After attention was given to thorough working no further trouble was experienced.

Some space has been devoted to an account of the defect in other countries and other parts of Australia in order to emphasise the point that the trouble is not unique to our State or, as has been suggested, to one factory. It is known that butter of this type has been manufactured at practically all factories in this State. The trouble of course becomes most evident when it appears in butter made from choice cream in factories which consistently make good-quality butter.

TENTATIVE CONCLUSIONS.

The conclusions from the information available are that:—

1. The defect is of bacterial origin.
2. The causative organism is probably water borne.
3. Foci of contamination are built up in the factory from initial contamination from the water. The most likely place for these foci is in the churns, between the staves in the worker glands, in the workers themselves, or in any other place where a lodgment of cream or other food material may occur.
4. Faulty manufacture probably assists in the development of the trouble. Thorough working safeguards quality.
5. High salt content and high acidity in the cream at churning apparently retards development of the fault.

While it must be realised that the whole story of this defect is not known, sufficient information is available to enable us to make suggestions for the control of the defect.

It is known that the heat resistance of the organisms responsible for the condition is not high and that ordinary pasteurising temperatures will destroy them. Therefore if pasteurisation is efficient there must be sources of contamination throughout the plant. It appears likely that the principal primary source

of the organisms is the water and so steps to purify the water supply are necessary. This can be effected by various types of steam and chemical sterilisers and bacterial filters. Where steam sterilisers are used, regular attention is necessary to make sure that they are working efficiently. Probably the most efficient system is the use of chlorine gas direct into the water supply.

There are many points in the various machines with which cream and butter come in contact which could be serious contaminating centres. Care is essential in order to be sure that satisfactory systems of cleaning and sterilising are employed. This appears to be particularly necessary in the churns, where prolonged heat treatment seems the most satisfactory method.

The percentage of salt used appears to have some bearing on the control of bacteria in butter and evidence is available to show a relationship with the development of surface taint. The majority of butters with this defect appear to have low salt content. In actual trials, Hammer showed that butter with 1.5 per cent. of salt and a low moisture content did not develop the condition. Loftus Hills showed development with 2 per cent. salt in sterile butter, but with 3 per cent. salt the condition was definitely retarded. It seems probable that some other factor was also operating in the cases cited, probably the number of lactic organisms present or the actual acidity of the butter.

Temperature is of course a controlling factor of bacterial development. Low temperatures may prevent deterioration in heavily contaminated samples, while higher temperatures would allow a rapid breakdown. In the retail trade, however, it is normal for butter at same stage to meet higher temperatures, and therefore it is particularly necessary to manufacture butter having only few organisms capable of causing change.

The texture of the butter or the degree of working appears to be an important factor in the development of bacterial troubles, and there have been indications that "rabbito" is related to the texture or the fineness of distribution of the water droplets. In measures suggested for the control of the defect therefore it is necessary to include attention to this aspect. The smaller the droplets of moisture in butter, the greater the number that will be sterile, and the smaller the amount of food material that will be available at the water fat junction, it being reasonable to assume that migration of organisms from one droplet to another does not take place.

In conclusion, the suggestions made may be summarised as under:—

1. Pasteurise efficiently.
2. Keep plant in a sanitary condition.
3. Purify the water supply.
4. Work the butter thoroughly so as to obtain a fine water incorporation.

If these are applied efficiently it should safeguard against any breakdown of this type.

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SOME FACTORS AFFECTING SEED POTATOES.

By E. T. MORGAN,
Officer in Charge, Potato Branch.

[*The following article is the text of an address broadcast through Station* 6*WF of the Australian Broadcasting Commission on Friday* 25*th February,* 1938.]

The opinion is held widely among potato growers that a variety of potato, if continually grown under the same soil and climatic conditions, will inevitably deteriorate, and that if the yield, quality and disease-resisting powers of the potato crop are to be maintained, it is necessary that new varieties which have been raised from true seed, should be introduced from time to time, or that a change of seed should be frequently made from different soil and climatic conditions. Many different opinions, however, are held regarding the ultimate cause or causes of this so-called deterioration and I want to discuss some of these in the light of the results of experimental work dealing with the subject which have been carried out in Scotland during recent years (*vide* Scottish *Journal of Agriculture,* No. I., Vol. VI.).

The experiments referred to were carried out for the purpose of obtaining information regarding the effect of—

(1) Continuously selecting large, medium or small sets.

(2) Continuously selecting seed from large plants and from small plants.

(3) Using seed obtained from a good crop and from a poor crop.

Large, Medium and Small Sets.

In the experiments referred to three varieties of potatoes, representative of well-marked types—Abundance, British Queen and Great Scot—were used. Three sizes of tubers of each variety were selected from the ordinary crop. The large tubers selected were twice the size of the medium, so that when these large tubers were cut in two with the medium size uncut, the sets were the same size and weight. On the other hand the small sets selected were half the size of the medium sets. All three were then planted under identically the same conditions and the same method of separation was practised in subsequent years; that is, every year the large sets were selected from the plants arising from the large sets, medium plants arising from medium sets and small from plants from small sets.

After a five-year period the averages worked out at--

Abundance.

Large sets, 16 tons 7 cwt per acre; Medium 15 tons 6 cwt., and Small 15 tons.

British Queen.

Large 15 tons 18 cwt., Medium 16 tons 7 cwt., and Small 15 tons 7 cwt.

Great Scot.

Large 17 tons 3 cwt., Medium 17 tons 13 cwt., and Small 15 tons.

Regarding these figures it may be pointed out that the medium sets have in the main given rather the heaviest crop and that the lightest crop, on the other hand, has been got from the use of small sets. Generally it is found advantageous to

use good sized seed (2 to 3 ozs.) rather than small, because with the larger food store in the seed the plant gets a better start and the crop is almost invariably heavier. The important fact stands out that the relative yields from the three classes of sets were practically the same at the end of the five-year experimental period as they were at the beginning. If selection in this way has any effect at all, it would naturally be cumulative, but there has been no falling away in yield from the use of the small sets, nor any addition to the yield from the use of the medium and large cut sets. That is to say, the continued selection of the small sets has not led to any deterioration; neither has the continued selection of the large sets led to any improvement.

It was further observed in each year when the crop was harvested that the proportion of small tubers from the small sets was not any greater than from the medium or large sets. Indeed, it was noted that from the large cut and from the small sets there was rather a larger proportion of what may be termed show specimens than from the medium sets. In the case of the small sets, in one or two seasons there was considerable difficulty in getting a sufficient number of small tubers to continue the trials.

One point of interest which emerged in these trials, but which has no direct bearing on the subject under discussion, was that the crop from the medium sets not only tended to be the largest, but it also ripened slightly earlier than that from the large cut and small sets.

Seed from Large and Small Plants.

As many growers still hold the opinion that improvement can be effected in a potato variety by taking sets from specially selected, large, strong growing plants, and that, conversely, deterioration can be brought about by selecting tubers continuously from small weak growing plants, a further series of experiments was carried out for the purpose of testing more fully and accurately how far these ideas are justified. In this case, a number of strong growing plants and a number of small plants were selected from an ordinary field crop of the same variety. *Special care was taken to see that all the selected plants were entirely free from disease.* Tubers of exactly the same size from each class were then taken and planted separately in drills alongside each other. In the first year it was found that the tubers from the strong growing plants gave rise to both large and small plants, as also did the plants from the small specimens. The same system of selection was practised in subsequent years—each year tubers from the best plants, the progeny of tubers from the best plants being selected on the one hand and the progeny of the smallest plants from tubers of the smallest plants on the other. An examination of the table of results shows that the average yield of tubers from the selected large plants at the commencement was 3 lbs. 11 ozs. and from the small selected plants only 12½ ozs. In subsequent years, however, the average yield per plant from both classes was almost identical and in the last year of the five-year experimental term was in the case of the large plant selection 2 lbs. 3 ozs. and in the case of the small plant selections 2 lbs. 2 ozs., the difference being almost entirely negligible and being more than covered by the ordinary experimental error.

A closer examination of the table of results showed, too, that in the case of the small plant selections quite as large a yield was had from some of the plants as from those in the large plant selections. Even after five years of continued selection along these lines the average yield from the large plants did not improve, neither was there any falling away in the yield from the selection of small plants. It is noted, too, that there was no difference in the average weight

of the tubers from the two series. These figures (I am quoting the text of the table of results) prove conclusively that no improvement has been effected by the continued selection of sets from large plants and that, so long as the plants are healthy, deterioration need not necessarily follow where sets from small plants are continuously used.

These results are quite in keeping with the ideas generally held at the present time regarding selection within pure lines. A potato variety or strain that has originated from one single plant is a pure line in the strictest sense of the term, and inside a pure line it has been proved that continued selection can effect no change. The only possibility of improvement or deterioration in the potato, or indeed in any plant that is progagated asexually, is where bud variation takes place, but all authorities agree that bud variation is so rare, except perhaps as regards colour, that it need scarcely be taken into consideration at all in this connection. It is true that many claim to have improved a pure strain by single plant or single tuber selection only, and have evidently succeeded in doing so, but in such cases it will probably be found that the weak plants dealt with were weak simply because they were attacked by some such disease as mosaic or leaf roll, or that the crop at the outset was really a mixture, and that the selection was what is known as "rogueing" and therefore any improvement effected was merely brought about by the elimination of the above quoted virus diseases or of inferior varieties.

Seed from Heavy and Light Crop.

A further series of experiments was conducted to find whether potato sets from a heavy crop would give a better return than seed from a light crop of the same variety and grown in the same soil. Five varieties were planted in a field where part was heavily manured and part left unmanured. At digging time tubers of the same size were selected from each plot. These were planted in alternate drills in a plot manured and cultivated in the same way, all over, so as to eliminate, as far as possible, any differences arising from inequalities in the condition of the soil. The result table shows that the seed was obtained from an average 12-ton crop from the manured section and six tons in the case of the unmanured section. In the following season, however, the yields from the seed from these two crops were practically the same, the average being 17 tons 4 cwts. and 17 tons 9 cwts. We see, therefore, that the treatment given to the crop from which the seed was originally selected had no effect whatever on the productive powers of the seed itself. Grown under the *same conditions of soil and manuring,* no permanent hereditary change has taken place leading either to improvement or to deterioration.

These results are interesting and go to show once again that deterioration is caused mainly by virus diseases. In these experiments it has been stressed that potatoes entirely free of disease had been picked as seed for the trials. The virus disease problem is not so great in Scotland as in some other countries, owing to the fact that the colder and perhaps more cultivated positions suppress many sucking insects which are responsible in the main for the transmission of such diseases. That better yields are obtained from the large and medium seed sets over those of the small sets has been demonstrated in this State in the summer-grown crop, but under our winter-planting conditions the size of the seed does not seem to be so important. This may be explained by the fact that the drier soil in the summer may draw some moisture away from the seed and the larger the set the more is it able to stand a certain amount of such drainage which would be detrimental in the case of the small set.

With the idea that seed potatoes from small plants, provided they are healthy, are just as good as seed from large plants, I am quite in accord, and this is demonstrated each year in the Denmark area. The seed crop for swamp planting is generally grown under adverse weather conditions from March to August and the tops in the main are small. Where sheltered conditions obtain growth is better, but the seed from the smaller plants does just as well as seed from the larger plants.

Now, under our climatic conditions we do find a weakening of vigour. This may or may not be temporary. In the case of our so-called "thready eye," where the tubers send out thin thread-like shoots instead of normal ones, if such are planted there is no progeny to carry on with. Where a weakening of growth takes place, as it often does if continually grown in light classes of soil, such weakening, if free of virus troubles, is temporary only and the vigour is regained if it is again planted in heavy soil. This is demonstrated by the fact that some of the potatoes produced in the lighter peaty swamps in the Albany area, when planted in the South-West in the hill crop, show quite weak, willowy growth, but when planted again in Benger Swamp or other heavy soil, the seed shows a "pick up" in vigour. There is little doubt that where crops mature in light soil under very high temperatures, as well as "thready eye," vigour temporarily suffers, but looking at the results of the experiments quoted we may consider that if a potato variety is kept pure and free from disease and is grown under suitable soil and climatic conditions there need be no deterioration. I may conclude by quoting that at Marybrook, near Busselton, some growers have not had a change of seed for ten years; attention has always been paid to rogueing of the seed plot, of course, and their crops are just as good, or better, now, than they were ten years ago. The winter and summer crops are grown on practically the same class of soil, but in spite of this the seed still retains its vigour, thereby suggesting that such soil and climatic conditions are suitable for continued production.

CLEAN MILK COMPETITIONS, 1937-38.

Conducted in the Balingup and Manjimup Districts.

B. WILLIAMS, Agricultural Adviser (Dairy Branch).

During the last season from November to January, two Clean Milk Competitions have been conducted with the object of ascertaining the quality of milk as delivered to the cheese factories in Balingup and Manjimup, respectively, and, wherever possible, to improve upon the present high standard of production. The first competition of this nature to be held in the State was conducted at Balingup in 1936, the success of which was clearly evidenced by the resultant improvement in the quality of the milk being supplied for cheese-making.

In 1937 the Manjimup Dairy Produce Company made available a sum of £5 together with a trophy of the same value for a continuous competition to be held over a period of five years.

In order to retain permanent possession of the cup, a supplier must win the competition for two consecutive years or, alternatively, gain the highest aggregate of points over the five-year period.

It was arranged that the competition should be adjudicated by an officer of the Department of Agriculture, whose decision would be final and also would provide an opportunity for the Department to come into contact with any difficulties arising in those districts from which the milk supply was drawn.

In order to judge the reliability of each supplier in maintaining the standard of quality, it was necessary to make three visits to each cheese factory. Accordingly inspections were carried out at Balingup on the following dates:—16th November, 1937, 21st December, 1937, and 26th January, 1938; and at Manjimup on 18th November, 1937, 23rd December, 1937, and 27th January, 1938, respectively. The date of each visit was not announced, thus eliminating special precautions being taken in the production and handling of the milk; thus the samples taken were truly representative of the supply of each competitor.

The actual judging was based upon the results of two tests, one physical and the other biochemical. The former, the sediment test, is one in which 500 c.c. of milk are pumped through a fine cotton wool pad. This pad will remove any foreign materials, curds or slime from the milk and also absorb any colouring fluid, to some extent, which may be present, thus giving a visible indication of the quality of the sample. For the latter the reductase test was used. This involves the principle that the dye methylene blue, in suitable concentration, is discolourised by reducing substances naturally present in milk, when the quantity of available oxygen is exhausted by living bacteria. The rate at which lactic and other acids are formed, and the rate of decomposition of proteins and fats present in the milk is approximately proportional to the number of living bacteria present and the rate at which they are working—this latter factor depending very largely upon the temperature. Thus the keeping quality of a sample may be determined by noting the period necessary to reduce the colour of the methylene blue. Milk, it must be remembered, is an excellent medium for the growth of many types of bacteria. When gaining access to milk, many of these organisms will render it unfit for human food in a very short time, if the temperature is suitable to their growth. Thus the reductase test is in effect a measure of keeping quality based upon the initial contamination with bacteria and their subsequent rate of multiplication.

A standard procedure was adopted, using methylene blue of $\frac{1}{2000}$ concentration. One c.c. of this solution was placed in a test tube and 9 c.c. of the milk sample added, giving a final concentration of $\frac{1}{20000}$ when the two were mixed. This quantity is sufficient to impart a light blue colour to the milk. The sample was held at room temperatures and examined every 15 minutes until the dye was entirely discolourised. The time was noted and points awarded as indicated by the graph included in this article. For the purpose of the competition, it was decided to allot a maximum of 40 points for the sediment test and 60 points for the reductase test. The scoring of the sediment pads was based upon the quantity and type of extraneous matter present, i.e., dust, hairs, scales, insects, curd, blood, chaff, etc., and the relative amount of injury which they may cause to the milk.

The following tables show the results obtained in the competition at each centre:—

TABLE 1.

BALINGUP CLEAN MILK COMPETITION.

Place.	Competitor.	November.			December.			January			Grand Total, 300 Points.
		Sediment Test 40 Pts.	Reductase Test 60 Pts.	Total 100 Points.	Sediment Test 40 Pts.	Reductase Test 60 Pts.	Total 100 Points.	Sediment Test 40 Pts.	Reductase Test 60 Pts.	Total 100 Points.	
1	H. Scarr ...	34	40	74	39	60	99	37	60	97	270
2	G. Blythe .	30	60	90	25	60	85	32	60	92	267
3	N. Baxter ...	33	60	93	32	40	72	39	60	99	264
4	W. Grime	23	60	83	31	19	50	32	60	92	225
5	E. Churchill ...	33	60	93	28	0	28	37	60	97	218

TABLE 2.

MANJIMUP CLEAN MILK COMPETITION.

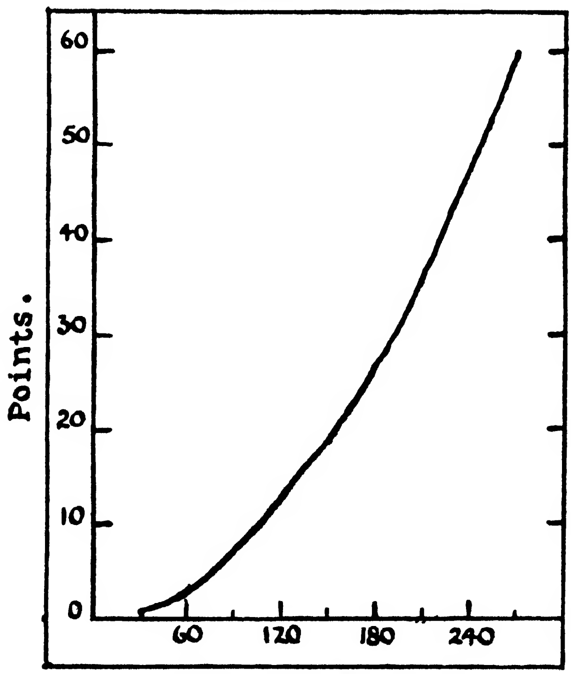
Place.	Competitor.	November.			December			January.			Grand Total, 300 Points.
		Sediment Test 40 Pts.	Reductase Test 60 Pts.	Total 100 Points.	Sediment Test 40 Pts.	Reductase Test 60 Pts.	Total 100 Points.	Sediment Test 40 Pts.	Reductase Test 60 Pts.	Total 100 Points.	
1	Depot No. 1	35	60	95	35	60	95	33	60	93	283
2	R. Eaton	33	60	93	28	60	88	28	60	88	269
3	G. Pozzi	31	60	91	20	60	80	23	60	83	263
4	W. Arnott	35	60	95	24	60	84	20	60	80	259
	E. G. Austin	27	60	87	32	60	92	20	60	80	

The total number of entries received was 115, i.e., 38 in Balingup and 77 in Manjimup. The winners in each district are to be congratulated upon the production of a very high quality product which speaks well for their cleanliness and attention to detail so necessary in the warmer summer months.

The following graph shows the method of allotting points for the reductase test:—

Table 3

Reductase Test.



Time in Minutes necessary for complete reduction of colour.

While conducting the tests, several points of importance became evident, and these may be summed up as follow:—

1. Sediments composed chiefly of fine dust, which had not dissolved into the milk, did not appear to impair keeping quality seriously.
2. Sediments containing hairs, scales, etc., indicated a milk of poor keeping quality.
3. Sediments containing albuminous and cheesy curds indicated a milk of very inferior keeping quality.
4. A general brownish discolouration of the pad indicated poor quality. Possibly dirty rinse water or blood from unhealthy cows would be the cause.
5. The mixing of night and morning milk in the one can causes quicker souring than either the night or morning milk separately.
6. Albuminous matter was most frequently traced to herds containing sick or freshly calved cows.
7. *The keeping of milk at low temperatures was by far the greatest assurance in maintaining a high standard of quality.* This point was very clearly shown on one occasion following a hot sultry night, when those farmers chilling their milk as a routine practice showed out to great advantage over those whose milk was not efficiently cooled.

The following tables show the number of suppliers delivering milk at the two centres and the number of good, fair, and poor quality samples obtained respectively.

In table 5 it will be noticed that the percentage of good quality milk rose from 21 per cent. to 37 per cent. over a period of three months, also the percentage of poor quality milk decreased from 34 per cent. to 10 per cent. over the same period. This clearly shows that, despite the drier and hotter conditions experienced in the summer, it is possible to obtain good results when special care is paid to sanitation and the maintenance of the minimum possible temperatures throughout all phases of production from the drawing of the milk from the udder to its delivery at the factory.

It will be noticed that, both at Balingup and Manjimup, the quantity of poor quality milk being delivered during December rose considerably. The reason for this was probably the hot sultry conditions experienced which were coincident with the time of testing and resulted in many samples scoring only low points in the reductase test. This alone is a very sound argument in favour of cooling the milk as soon as possible to as low a temperature as can be obtained.

Considering all competitors as a whole, it was pleasing to note that the amount of foreign material present in the samples, as shown by the sediment test, was considerably reduced in December and particularly in January. When one calls to mind the general conditions prevailing in these areas in January, one would expect to find a greater amount of foreign material, as the pastures are dry and the air is heavily laden with dust. This indicated that considerable attention was paid to the protection of the milk from the air and with good results.

TABLE 4.

ANALYSIS OF MILK SUPPLIED TO THE BALINGUP CHEESE FACTORY ACCORDING TO GRADE.

BALINGUP.

Grade.	Samples in each Grade.					
	November.		December.		January.	
	No.	%	No.	%	No.	%
Good—80-100 points	9	21	3	8	14	37
Fair —40-79 „	17	45	14	37	20	53
Poor — 0-39 „	18	34	21	55	4	10

TABLE 5.

ANALYSIS OF MILK SUPPLIED TO THE MANJIMUP CHEESE FACTORY ACCORDING TO GRADE.

MANJIMUP.

Grade.	Samples in each Grade.					
	November.		December		January.	
	No.	%	No.	%	No.	%
Good—80-100 points	36	47	29	39	23	33
Fair —40-79 „	11	14	5	7	21	30
Poor — 0-39 „	30	39	40	54	25	37

TABLE 6.

TABLE SHOWING THE NUMBER AND PERCENTAGE OF SUPPLIERS IN EACH GRADE OVER A PERIOD OF THREE MONTHS.

Grade.	Balingup.		Manjimup.	
	No of Suppliers.	Percentage.	No. of Suppliers.	Percentage.
Good—240-300 points	3	8	8	10
Fair —120-239 „	28	74	50	65
Poor — 0-120 „	7	18	19	25

The Competition has shown that it is not difficult to produce milk of high quality, provided that careful attention is paid to detail as regards cleanliness in every operation during its production and handling.

INOCULATION OF SHEEP AND CATTLE AGAINST TOXIC PARALYSIS.

The Department of Agriculture desires to advise farmers that it will no longer supply the vaccine for the inoculation of sheep and cattle against toxic paralysis. Persons desiring vaccine should forward their orders direct to the Chief Quarantine Officer (General), Department of Health, General Post Office Buildings, Perth, who will in future have control of supplies.

Owners are advised to inoculate their sheep and cattle during August or September in order to give them the necessary protection for the summer months.

THE PEA WEEVIL, BRUCHUS PISORUM (LINN).

By L. J. NEWMAN, Government Entomologist
and
H. G. ELLIOTT, Agricultural Adviser (Dairy Branch).

The spread of this pest has undoubtedly been brought about per medium of the sale and distribution of infested seed. In spite of the regulation which reads as follows:—"No person shall sell, supply, distribute, deliver or dispose of any field peas, to any other person, unless and until such field peas have been fumigated with Carbon-bisulphide in such manner as effectually to render the same free from the disease of Pea Weevil," there have undoubtedly been large quantities of infested seed sold and carried into previously clean areas.

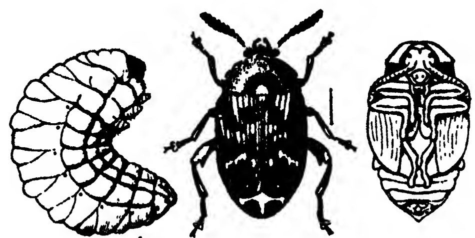


Fig. 1.—Pea Weevil: *a*, beetle; *b*, grub; c, pupa. True length of beetle shown by line at its right. (Chittenden U.S.D.A. *Yearbook*, 1898.)

The method of attack adopted by this insect renders control in the field economically impossible. The eggs are laid by the adult upon the outside of the young pea pod. The resultant larvae which issue immediately bore their way into the young developing seed and there ensconce themselves, slowly feeding and growing, reaching the adult winged stage when the seed matures.

The establishment of the Pea Weevil has rendered the growing of field peas (*Pisum spp.*) unprofitable for seed production.

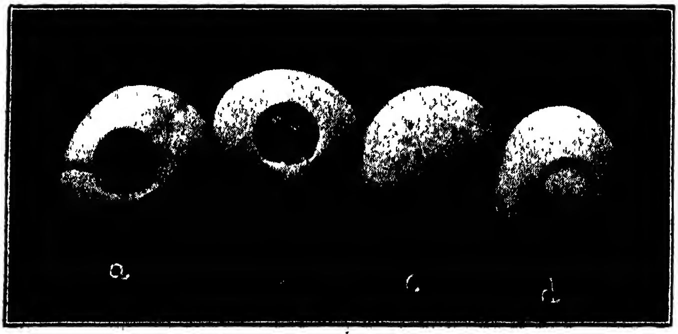


Fig. 2.—A.—Showing exit hole of adult weevil. B.—Adult weevil within pea ready to emerge. C. & D.—Infested peas showing typical indication of the weevil within.

Original.

The same insect also attacks the common garden pea but as this vegetable is eaten in the tender green stage, the young developing weevil grubs within are so tiny as not to affect the flavour or food value. If, however, the garden peas are allowed to mature their seed, the weevil will be found to be present in varying numbers according to the period of the year when they are grown, spring crops being the worst affected.

We have proved that this pest confines its attack to the field and does not, like grain weevils, continue to increase in storage. For further information concerning the life history and measures for control in stored seed, see the Departmental Leaflet No. 357.

In efforts to control this insect in the field, a series of planting trials was designed and carried out by the co-operation of the officers of the Dairying, Irrigation and Entomological branches during the 1936 season.

The object of these tests was to prove whether it was possible to overcome the trouble by varying the times of sowing. The results were not conclusive but encouraged the belief that by departing from the normal planting period (July) and sowing later, the percentage of infestation of the seed could be considerably reduced if not entirely prevented.

During 1937, a new set of field planting experiments was planned and carried out on the property owned and farmed by Mr. T. Tyrell, of Waterloo, situated on the South-Western Railway. The variety of pea used was that known as the Dunn Field Pea.

The variety usually grown in this area is the White Brunswick. The reason for using the Dunn Pea was that it was difficult to obtain weevil-free seed of the White Brunswick type.

An area of 1¼ acres, capable of being irrigated if necessary, was selected.

This land was previously under pasture, mainly subterranean clover and prior to that had grown field peas.

The land was divided into five ¼-acre plots and sown on the following dates:—

Plot 1. Normal planting period July 20th.
Plot 2. Sown August 16th.
Plot 3. Sown September 3rd.
Plot 4. Sown September 20th.
Plot 5. Sown October 4th.

The peas were planted at the rate of 2 bushels per acre with superphosphate 2 cwts. per acre on all plots.

The first four sowings were grown under natural rainfall. Plot 5 received one irrigation on the 23rd November but should the necessary late spring rains not eventuate it might be necessary to apply an earlier watering.

The plots were kept under careful observation during their growing period and the following results noted:—

1. That the normal July sowing and the August planting were seriously attacked and injured by Red Legged Earth Mite, Lucerne Flea, Looper Caterpillar, and Climbing Cut-worm.
2. That the early September sowing suffered in a progressively less degree from these pests.
3. That the late September and early October sowings were not seriously injured by these pests during their growing period.

In regard to the Pea Weevil, it was demonstrated that the crop from the mid-July planting was the most seriously affected. Up to 30 weevil eggs per pod were observed and most of the pea blossoms were damaged by the beetles feeding upon them. The August sowing, which podded in late October, was also found to be seriously infested, indicating that planting during that month did not overcome the trouble, the adult weevils continuing to be active. The September and October plantings flowered and podded during November and early December showing considerably less infestation.

When the crops ripened a representative sample of seed was gathered from each plot and carefully examined for the presence of weevil.

Plot 1. Normal mid-July sowing showed 92.5% infested seed.

Plot 2. Mid-August planting 73% infested seed.

Plot 3. Early September sowing 42% infested seed.

Plot 4. Late September sowing 45% infested. This is a slight rise on the early September planting which experimentally could be regarded as negligible.

Plot 5. Early October sowing 9% infested seed.

Summarising the results, it was found that the early sown peas are more susceptible to the attack of Red Legged Earth Mite, Lucerne Flea, Looper Caterpillars, Climbing Cut-worms and Pea Weevil.

Observations of the crop yields of each plot indicated that the variation in the planting periods did not reduce the returns per acre.

The extra cost involved in the one irrigation of the October-sown crop was offset by the greatly lessened percentage of weevil infested peas stripped. The possibility of using this information may provide in the wetter and irrigable areas a means of reducing the serious damage caused by the Pea Weevil and the other pests mentioned.

The Department proposes to continue these experiments on a larger scale during the coming season.

Further, in an effort to determine whether the weevil could be overcome by substituting other fodder plants, the following were experimentally tested at the Denmark Agricultural Research Station:—

1. Tangier Pea (*Lathyrus tangitanus*).
2. *Lathyrus sativa.*
3. *Lathyrus annus.*
4. *Vicia sativa.*
5. *Vicia atropurpurea.*
6. *Vicia monantha.*
7. Grey seeded Vetch (*Vicia sp.*).
8. Small seeded Horse or Tick Bean (*Vicia faba*).
9. Lentil (*Ervum lens*).
10. Austrian Winter Pea (*Pisum arvense*).

The growth of these crops was closely watched. When ripe a representative sample of seed was collected and with the exception of the Austrian Winter Pea (*Pisum arvense*) were found to be immune to Pea Weevil (*Bruchus pisorum*). It was thus demonstrated that this pest confines its attack to the *Pisum* group of peas.

The most outstanding varieties of those tested were the small seeded Horse or Tick Bean, Tangier Pea, *Vicia sativa, Lathyrus annus,* and the Grey-seeded Vetch.

M. T. PADBURY TROPHY COMPETITION.

I. THOMAS, Superintendent of Wheat Farming.

This competition, which is organised by the Royal Agricultural Society, was inaugurated in 1930, and was made possible by a generous donation by Mr. M. T. Padbury, a pioneer farmer of this State.

The trophy is a handsome shield and will be awarded to the competitor gaining the highest average yield of wheat per inch of rainfall during the conventional growing period (May to October) for any five years during the period of the competition (10 years). The winner of each year's competition is, however, presented with a replica of the trophy.

The conditions under which the competition is conducted are as follow:—

1. The competition will commence with the 1930-31 harvest and continue for a period of 10 years. At the end of that period the trophy will be awarded to the competitor who has taken part in the competition for at least five years, and who obtains the greatest mean average acre yield per inch of rainfall during the conventional growing period. The mean average yield will be computed from the results of the five seasons in which the competitor produced the highest acre-yield per inch of rainfall during the growing period. In the event of a tie the competition will continue between the leading competitors until an advantage is gained by one of them.

2. The conventional growing period for any year will be that decided upon and announced by the Royal Agricultural Society. For the first year, and until further notice, it was decided that it would be from 1st May to 31st October, inclusive.

3. Until the end of the competition the trophy will be in the custody of the Royal Agricultural Society, and will be displayed at any agricultural exhibition held by that society.

4. Each year the competitor who obtains the best average acre yield per inch of rainfall during the conventional growing period will be awarded a replica of the trophy. His name will also be inscribed upon a small shield affixed to the trophy.

5. The rainfall upon which the award will be made will be determined by the Commonwealth Meteorologist from the district records, and his decision in this matter will be final.

6. The competition will be limited to those farmers who harvest at least 200 acres of wheat for grain. Where a competitor is financially interested in the crops grown on one or more farms, he will be required to supply details regarding the production and marketing of the crops on same, and, though usually the award will be made upon the results from the farm nominated by the competitor, the Royal Agricultural Society may require that the crops on these farms be included in the competing area.

7. The average yield will be ascertained from the total area—including self-sown crops—harvested for grain, and determined from the actual amount of

wheat sold, as shown by the delivery dockets, plus the amount retained for seed, for home use or for any other purpose.

8. The method of judging will be as follows:—At a convenient time the area harvested for grain will be measured and the quantity of wheat on hand ascertained. On or before 31st January the farmer will be required to furnish the judge with a sworn declaration as to the quantity of wheat sold from the competing holding or holdings, and the amount retained for seed and other purposes; the statement regarding the amount sold to be supported by agents' dockets. The judge, after satisfying himself as to the correctness of this statement, will compute the average yield per acre per inch of rainfall during the growing period from the information received.

9. The judge will be appointed by the Director of Agriculture, and his decision will be final.

10. Nominations for this competition will be received by the Royal Agricultural Society up to the 31st October each year.

The eighth year of the competition has been completed with the 1937-38 harvest and the results for that season are now finalised. The winner was Mr. R. M. Jones, of Shackleton, with the excellent average yield of 3 bushels 16 lbs. per inch of rainfall from an area of 241 acres. He was closely followed by the previous year's winner—Mr. F. C. West, of Toompup—with 3 bushels 7 lbs., and the Hon. T. Moore, of Indarra, the winner in 1935, with 3 bushels 2 lbs.

The results for last season (1937-38) are given in the table below:—

M. T. PADBURY TROPHY COMPETITION.

1937-38.

Competitor.	Address.	Rainfall during Growing Period.	Area Harvested.	Yield. Gross.		Yield. Average per Acre.		Yield. Average per inch Growing Period Rain.	
		points.	acres.	bus.	lbs.	bus.	lbs	bus.	lbs.
Jones, R. M.	Shackleton	665	241	5,229	24	21	42	3	16
West, F. C.	Toompup	1,027	218	6,976	27	32	0	3	7
Moore, Hon. T.	Indarra	904	246	6,758	24	27	28	3	2
Bland, C. O.*	Corinthian	470	753	9,830	0	12	23	2	42
McCormack, T. B.	Nungarin	717	375	6,891	0	17	25	2	26
Perkins, C. C.	Belka	670	789	12,252	24	15	32	2	19
Barr, D. F.	Shackleton	715	482	7,869	24	16	19	2	17
Bremner, J. R. & Sons	Corrigin	744	874	14,441	6	16	21	2	13
Creagh Bros., Ltd.	Nungarin	632	1,007	13,437	42	13	2[illegible]	2	7

* This entry suffered losses from hail damage, but, under the conditions of the competition, any assessed losses cannot be included in the yields.

The average yield per acre of the nine entrants was 19 bushels 11 lbs., and the average yield per inch of rainfall during the growing period was 2 bushels 37 lbs.

In Table 2 particulars are given of those competitors who have taken part in the competition for three years or more and, therefore, are still able to compete

for the requisite five years, as stipulated in the conditions, before the termination of the competition with the 1939-40 harvest:—

M. T. PADBURY TROPHY RESULTS, 1930-37 (INCLUSIVE).

Competitors who have Competed for three or more years.

Competitor.	Address.	Average Yield per Inch of Growing Period Rainfall.							
		1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.
		bus. lb.	bus. lb.	bus. lb.	bus. lb.	bus. lb	bus. lb	bus. lb.	bus. lb.
Allen Bros.	East Kumminin	2 11	2 23		2 26	3 1			..
Atkins, F M & J L.	Jouerdine	2 41	3 0		3 39	4 29			...
Barnett, L T C.	Walgoolan	2 48	2 19	2 34	2 58				
Bremner, J. R. & Sons	Corrigin	1 55	2 10	1 48	2 32	2 37	2 12	1 49	2 13
Butcher, O J.	Pithara			2 42	1 58	4 8			....
Creagh Bros Ltd	Nungarin	2 20	2 16	1 43	2 12	2 41			2 7
Horsman, H. & Sons	Bilbarin	1 53	2 6	1 5	2 40				..
Manuel, C. J	Mukinbudin	2 44	2 10	2 5	2 5	3 4			...
Moore, Hon T.	Indarra		2 47	2 33	3 5		4 6		3 2
Nottage, R. B.	Tammin		2 36	2 21	3 23	4 13			
Prowse E W	Doodlakine	1 42		1 31		3 13			
Scadding, N A.	Kulin			2 4	2 10	2 49	2 27	1 35	
Smith, C & Sons	Yarding	2 21	2 29			3 57			
Snell, C & Son	Nangeenan	2 29			2 54	2 37			
Stewart, W B.	Gnowangerup	1 52	2 37	1 54	2 55	2 30			
Strange, P. A.	Yarding	2 36	2 6		2 48	2 33		1 48	
White, R H.	Gnowangerup	1 51	2 45		2 40	2 47	2 25		
Williams, F. A.	Mangowine	3 23	2 25	1 34					

CYSTS IN SHEEP.

A. McK. CLARK, L.V.Sc.,
Chief Veterinary Surgeon.

The attention of sheep breeders is drawn to the infestation of sheep with tapeworm cysts. It is reported that up to 12 per cent. of the carcases from some flocks are infested. The position is so serious that some effort should be made to minimise this infestation so as to avoid the great economic loss which is occurring, and which will continue unless some effort is made to prevent this infestation. Fortunately, the methods of prevention are not difficult, but require that the dogs, and particularly sheep dogs, should be treated at least once in three months.

The tapeworm cyst (*Cysticercus ovis*) is a cloudy coloured bladder-like formation distended with fluid which may be seen particularly on the outer surface of the liver. It is also found deeply seated in the heart and other muscles. These cysts are the intermediate stage in the life cycle of the tapeworm (*Taenia ovis*) of the dog. The dog, and particularly the sheep dog—because of its association with sheep—is spreading the cyst through depositing the tapeworm segments in the water supplies or on the pastures in its droppings. From there they are taken up by the sheep. It is obvious, therefore, that in order to minimise the infestation of sheep with these segments the dog should be rid of the worm by treatment. It is recommended that dogs should be treated at least once in three months with 2 grains of powdered Areca nut for every pound of the dog's weight, or 1 grain of Arecoline Hydrobromide dissolved in 2 ounces of water; give one tablespoonful of this solution as a dose for a 20lb. dog. The whole course of this treatment will not cost more than 6d. per annum. Care should also be taken that dogs are fed only with cooked meat.

FERTILISERS—ADDITIONAL REGISTRATIONS.

The last March issue of this Journal contains a list of additional registrations of fertilisers, to that contained in the December issue, for the current year together with the minimum percentages of the fertilising ingredients. Further additional registrations, with the respective analyses, are shown in the following table:—

Name of Fertiliser.	Reg. No.	Brand.	By Whom Registered.	Nitrogen (N) as				Phosphoric Acid (P_2O_5) as				Potash (K_2O) as		Cash Price per ton on Rails, Perth.
				Nitrate.	Ammonia.	Blood and Bone.	Bonedust.	Water Sol.	Citrate Sol.	Acid Sol.	Total.	Sulphate.	Muriate.	
				%	%	%	%	%	%	%	%	%	%	£ s. d.
Fertiliser	144	Apollo	J. Kitchen & Sons Pty., Ltd.			7·0			14·0		14·0			10 7 6
Blood and Bone	145	Riverstone	Riverstone Meat Co. Pty., Ltd.			5·5			5·0	0·25	14·25			7 5 0†
Dried Blood	146	do.	do. do. do.			13·0								13 10 0†
Blood and Bone	147	Albany Freezing Works	Albany Freezing Works, Ltd			6·0					12·0			9 10 0*
Phosphatic Guano	148	Cormo	M. F. Phillips, Shark Bay				1·37				23·89			*a*
Fish Fertiliser	149	do.	do. do. do.				6·2				6·2			*a*
Blood and Bone	150	Robb's	West Australian Meat Export Co., Ltd.			5·25					14·0			9 5 0
Potato Manure	151	Eclipse	do. do. do.		3·0			16·0		0·25	16·25	4·25		7 10 0
B.S.P.	152	do.	do. do. do.		1·2			5·0		9·0	14·0		1·2	5 5 0

† Price f.o.b. Sydney. * Price ex works. *a* Price on application.

PREPARING SHEEPSKINS FOR MARKET.

By Hugh McCallum,
Sheep and Wool Inspector.

There is great need for more care in the treatment and packing of sheepskins for market. Many consignments forwarded for sale are carelessly prepared and consequently receive a lower classification. This is unnecessary and reveals bad management. A little more care on the part of the farmer will result in a handsome profit due to the increased price per pound of the consignment.

Fig. 1.—Skinning the carcase.

Except in the cases of skins from dead sheep, ribby and grass seed pierced skins, any classed as "damaged" indicate bad methods of skinning, drying, preserving or packing. These methods may result in cut or torn skins, weevil eaten, sun dried or shrunken and wrinkled skins.

The losses incurred by forwarding these inferior skins for sale may be easily avoided if, in preparing the skins, the following general methods are adopted by the farmer.

SKINNING.

Excessive use of the knife is a bad practice, and with accomplished skinners its use is restricted to as few parts as possible. It is usual to commence by inserting the knife under the skin at the knee of the foreleg and opening down to the point of the brisket, then up the throat, the other foreleg being done similarly. The

Fig. 2.—Final operation of skinning.

skin should be lifted off the brisket and punched off over the belly, finally cutting down from the hocks to under the tail and skinning around the butt. From this point there is usually no further need of the knife for skinning, only for cutting. When the sheep is on the hooks the skin is cut down from between the legs to the brisket and then carefully pulled off from the back with punching, down to the back of the head and cut off with the ears still attached. See Figs. 1 and 2. By

punching wherever possible the danger of cutting the pelt and the likelihood of attachments of fat, which make preserving difficult, is decreased. It is very desirable to prevent the wool from becoming bloodstained, and this is facilitated by allowing the sheep to bleed fully before commencing to skin. Wash off all blood before it dries and wring out the wool.

DRYING AND PRESERVING.

The fresh skin should be stretched out flat under shelter in a desirable shape as indicated by fig. 3. Care should be taken to prevent the edges of the pelt rolling in and it should be stretched out well at the neck. It usually takes six or more

Fig. 3.—Laying out the skin.

hours for the pelt to set and it should then be painted with an anti-weevil solution. See Fig. 4. Special care should be taken in painting the edges and neck. There are many effective arsenical washes being used for this purpose. A solution of sheep dip, too, is suitable.

Although the above method is preferable, in some cases there is a shortage of available floor space and fresh skins can be placed over rails. See Fig. 5. Never store skins on top of one another as they sweat.

When the paint is dry the skin should be hung lengthwise over a rail under shelter with flesh side up, allowing the trotters and legs to hang down either side.

See Fig. 6. Not as in Fig. 7. The skin should be sheltered from sun and rain, both of which damage the pelt.

PACKING.

When the skins are dry and there are sufficient to make a bundle, all trotters should be cut off and the skins folded along the back line with the wool outwards. See Fig. 8. They should be placed on top of each other with the folded back line alternately on either side. The neck end should also be alternated and all ends tucked in. See Figs. 9 and 10. The bundle can be weighted or levered down and

Fig. 4.—Painting with arsenical solution.

should be secured by wire. See Figs. 11 and 12. Rope or binder twine is not recommended as fibre is liable to be left in the wool. The finished bundle should be compact, neat and easy to handle. See Figs. 13 and 14.

In consigning them the broker should be advised of the number of skins, each bundle being labelled separately. It is important that the loose ends be folded in as they may be used by handlers for shifting the bundles, with a possible consequence that the skins are torn.

Fig. 5.—Placing the skin on a rail.

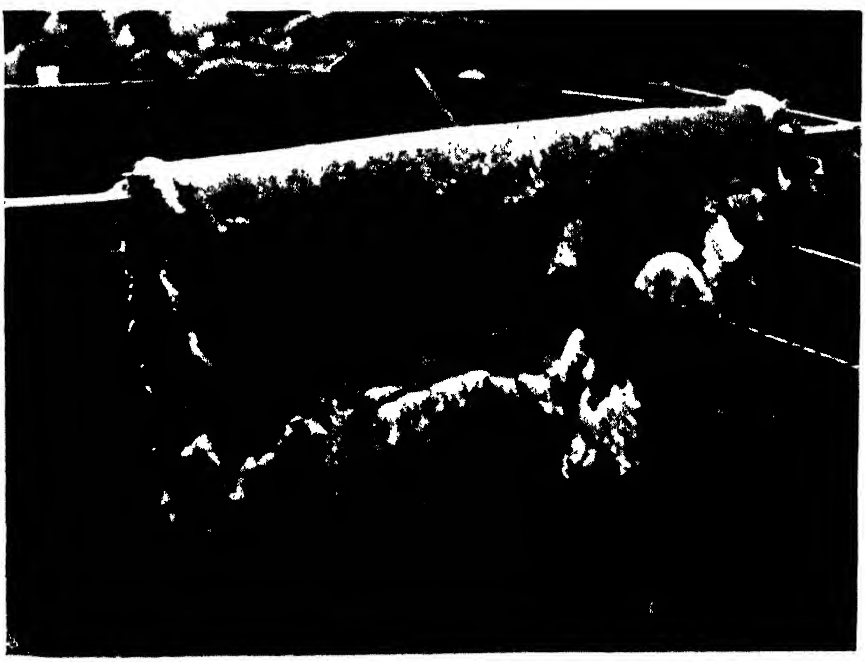


Fig. 6.—Skin properly hung to dry.

Fig. 7.—The wrong way.

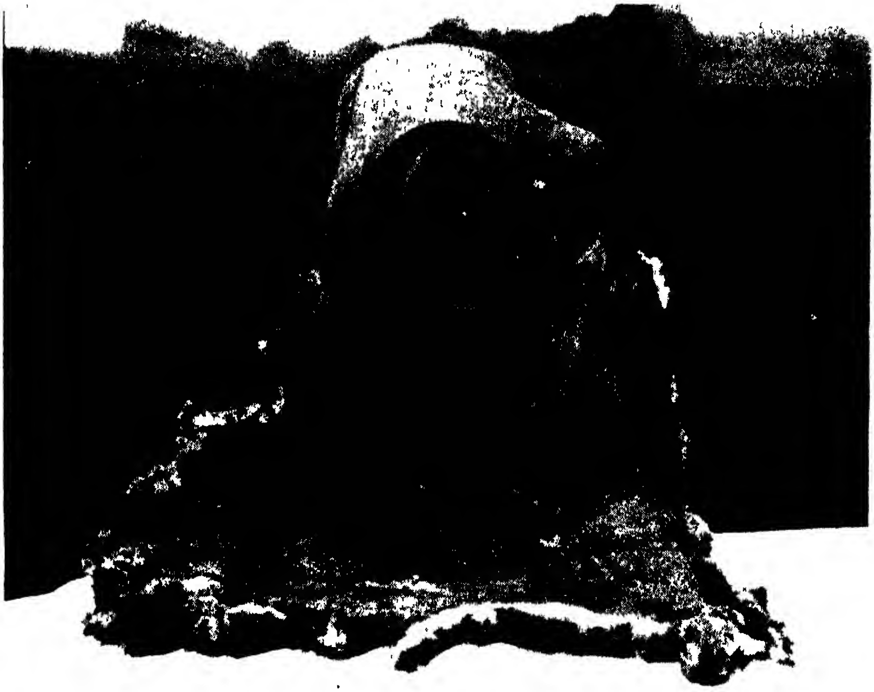


Fig. 8.—Folding the dry skin.

Fig. 9.—Properly folded.

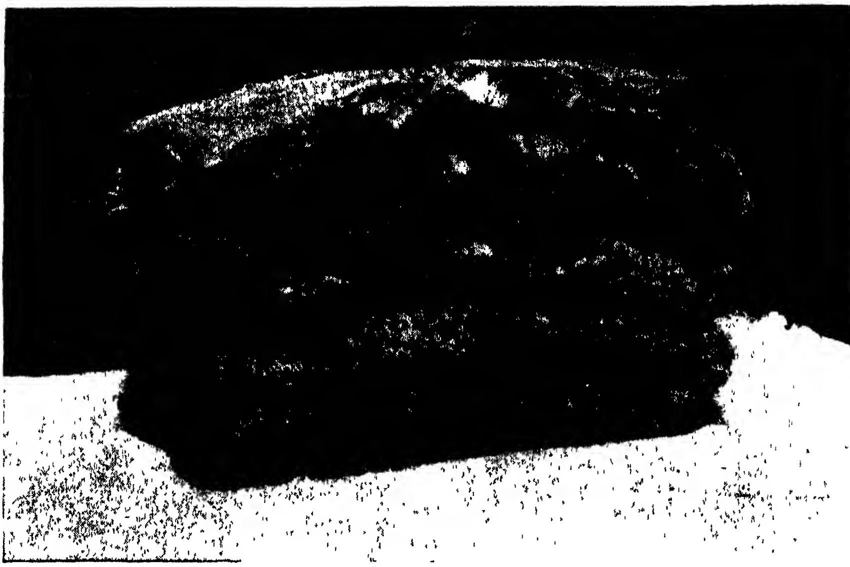


Fig. 10.—Stacking for packing.

Fig. 11.—Pressing.

Fig. 12.—Wiring.

Fig. 13.—The bundle completed.

Fig. 14.—Ready for market.

BACTERIAL BLIGHT OF BEANS.

H. A. J. PITTMAN, B.A., B.Sc.Agr. (Hons.), Dip.Ed.,
Plant Pathologist.

Prior to the 1930-31 season the "Canadian Wonder" bean crops (*Phaseolus vulgaris,* L.) in this State had always been, so far as is known, quite free from any bacterial disease. In November, 1930, however, complete losses of crops of this variety were caused at Maddington, by a disease which was readily diagnosed as a "bacterial blight," the major part of the losses, if indeed not all, apparently being due to the bacterium known as *Phytomonas medicaginis* var. *phaseolicola.* The seed from which these crops were grown had been obtained from Orbost, Victoria, where a huge bean seed-raising industry had been established, which at that time supplied practically all the "Canadian Wonder" bean seed planted in Australia.

Shortly after the first outbreak of the disease in this State, news came to hand per medium of the Eastern States press that total crop failures had been reported during the 1930-31 season from South Australia and many parts of Victoria, due

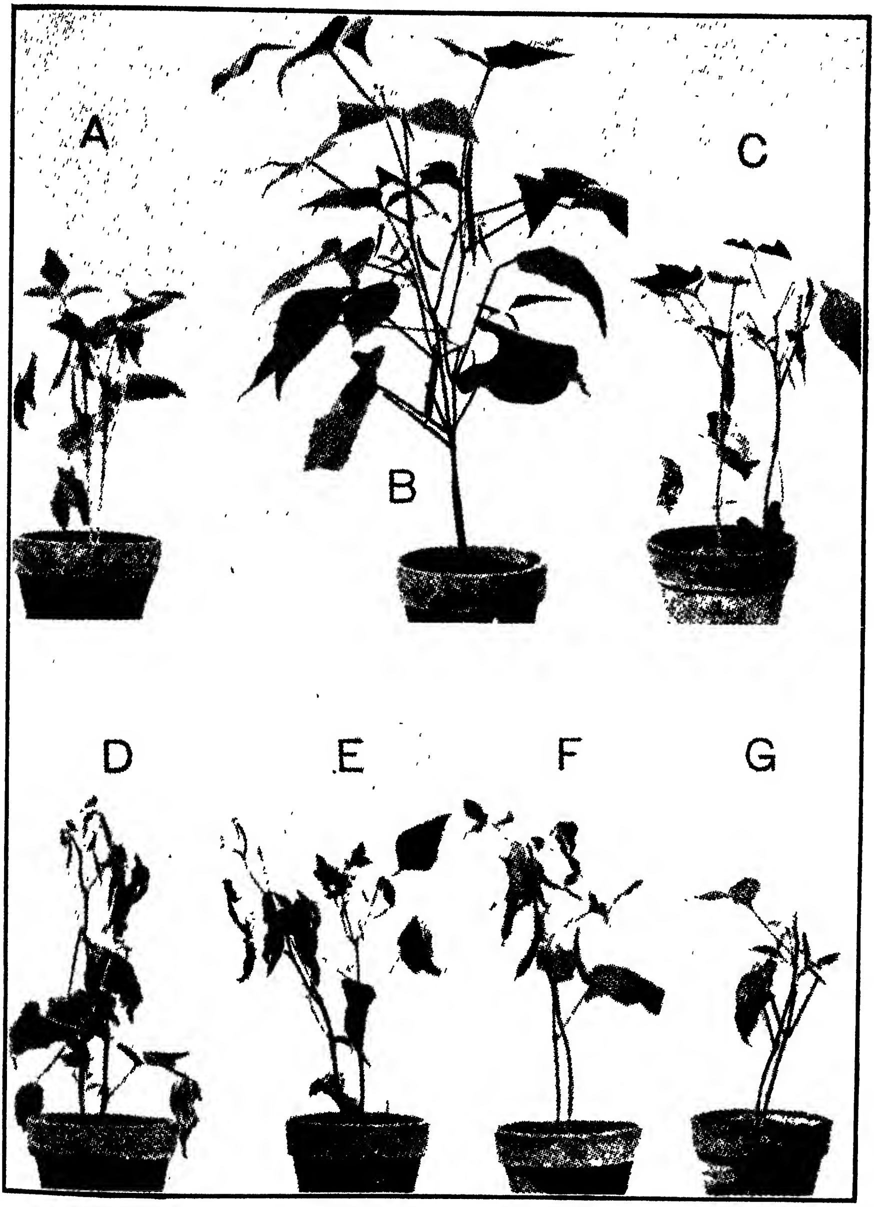


Fig. 1.—Wilts of "Red Kidney" bean plants one month after inoculation with various bacterial pathogenes.

The plants were inoculated at the first leaf node. A, *Phytomonas medicaginis* var. *phaseolicola;* B, check; *C, Phyt. phaseoli* var. *fuscans;* D and E, two strains of *Phyt. phaseoli;* F and G, two strains of *Phyt. flaccumfaciens.*

B represents a perfectly healthy uninoculated control plant photographed on the same scale as the others.

(*After Burkholder, "The Bacterial Diseases of the Bean," Cornell University Agric. Expt. Sta. Memoir* 127, *April,* 1930.)

to the ravages of a bacterial blight. This disease, caused by *Phytomonas medicaginis* var. *phaseolicola,* has since been reported from New Zealand (W. D. Reid, N.Z. *Journ. Agric.* Vol. 43, No. 6, Dec., 1931, pp. 408-415) and Queensland (L. F.

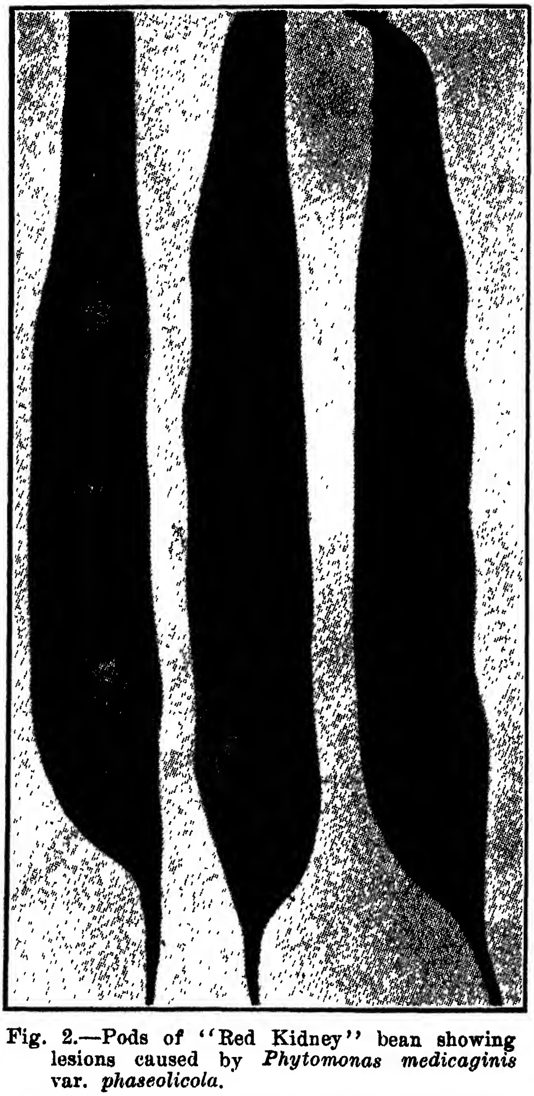


Fig. 2.—Pods of "Red Kidney" bean showing lesions caused by *Phytomonas medicaginis* var. *phaseolicola.*

(*After Burkholder, "The Bacterial Diseases of the Bean," Cornell University Agric. Expt. Sta. Memoir* 127, *April,* 1930.)

Mandelson, Queensl. *Agric. Journ.*, Vol. 37, Part 2, pp. 128-33, Feb. 1932), and it has led to very severe losses in the big bean-growing district of Gosford, New South Wales.

Samuel (*Journ., Dept. Agric*, South Aus., Vol. 34, No. 7, Feb., 1931, p. 746) records a bacterial spot of beans in South Australia as being probably due to *Phytomonas medicaginis* var. *phaseolicola.*

Since the first occurrence of the disease in this State, devastating losses have occurred at Nedlands in extra early crops of "Canadian Wonder" beans, and also of the same variety at Geraldton, Balcatta, Spearwood, and other places where market-gardening activities are extensively practised.

SYMPTOMS OF THE DISEASE.

On entering a field severely affected with bacterial blight, the first impression gained is that the germination has been very irregular, and that the affected plants are suffering from nitrogen starvation combined with the effects of an exceedingly severe drying wind, although it may be very well known to the observer that neither of these things could possibly be the cause of the trouble. In a number of patches where the disease obviously first appeared, all that will be left of the affected plants will be a few stiff stems with shrivelled and dried-out leaflets still hanging to, in some cases, or else fallen from, the leaf stalks or petioles, which usually remain stiffly erect. A number of the plants may have grown little, if any, further than the seed-leaf stage.

A number of the leaves may have fallen away from the plants at the abscission layer near the base of the leaf-stalk (petiole), while in other cases the leaflets will have dropped off with their own stalks (petiolules), leaving the petioles projecting stiffly into the air. The swellings at the base of infected petioles may be very much watersoaked in appearance and still quite green, even though the end of the petiole is browned and shrivelled.

If the weather conditions are moist at the time, or if the plants are growing in a very moist situation, or have been recently heavily watered with a sprinkler, beads of bacterial slime may be found exuding from the joints or nodes on the stem, just below the bases of the petioles, or from the wounds left by the falling away of the leaflets, leaves or cotyledons (seed leaves). Elongated, very irregular, slightly sunken, brown lesions with a reddish-brown margin may occur on the stem, and a more or less complete brown girdling of the stem with a reddish margin and considerable bacterial ooze may be located at the point where the seed leaves were formerly situated. Some of the leaflets which have not yet dried out may show a considerable number of rusty-brown, more or less confluent, small irregular lesions between the veins, the remainder of the leaflet having a very sickly, nitrogen-starved, mottled appearance. Such leaves are frequently very ragged at the margins and "shot-holed" in appearance. Small, dark-green, watersoaked, or brownish dead areas may occur on the leaflets, each spot being surrounded by a comparatively enormous pale-green halo. The presence of this characteristic halo has led to the disease being known elsewhere as "Halo Blight."

Affected *pods* may show one to very numerous more or less circular dark green watersoaked lesions, from which bacteria may exude in beads in moist weather, in a very moist situation, or when placed for a day or so in a moist jar. These areas later on may dry out and become more or less reddish or brown in colour. The diseased areas may run together and cause malformation and withering of the infected pods.

Early sown and late autumn crops are generally the most severely affected, as cool, moist, atmospheric conditions are more favourable for the spread of the disease than hot, dry conditions. The danger from bacterial blight is greatest in the localities which would otherwise be the most suitable for the production of very early crops, that is in the frost-free coastal areas and picked spots close to the Swan River or other favoured locations. The disease is apparently spread about

in the field from the primarily-infected plants by driving rain, hail, overhead watering, insects, or cultivation and harvesting operations when the plants are in a moist condition. The spread of the disease in the field under suitable conditions may be exceedingly rapid.

CONTROL.

The disease is carried by the seed, and the only known control measures are to plant seed harvested from disease-free crops, on new land, or land that has not grown an infected crop for at least three years; or to plant resistant or immune varieties.

Since infection is not only carried on the outside of the seed, but actually in a number of cases inside the seed coat, adequate seed disinfection is impossible, as any treatment severe enough to kill the bacteria within the seed coats would also kill the seed.

The appearance of the seed may give no indication as to whether the disease is present or not, as perfectly healthy-looking seed may be carrying sufficient infection to give total crop failure under suitable climatic conditions.

Bacterial blight can only be detected with any degree of certainty in the seed by a long and tedious laboratory investigation, or, better still, by actually growing a representative sample of the seed in disease-free soil prior to the planting of the bulk, and carefully observing the test seedlings for any signs of disease. In the seedlings bacterial blight may be recognised as small diseased spots which develop on the cotyledons (or seed leaves), which are attached to the top of the stem when the seedling stem appears above ground.

In view of the disastrous result that almost inevitably attends the introduction of even a small percentage of infected seed on to a property, **growers who know that their land and crops are clean are strongly advised to raise their own seed, even though it may be contrary to their practice and inclination to do so.** It is important to remember that bacterial blight is carried almost solely by the seed, and properties that are now clean may therefore be kept so perhaps indefinitely by the expedient of planting only clean seed.

Clean seed may be obtained from an originally diseased line, by growing a crop during the hot dry weather, provided that artificial waterings, if necessary at all, are kept down to the irreducible minimum, and that the diseased plants are pulled out and burnt as soon as noticed. To inhibit spread of the disease from affected to healthy plants the seed should be much more widely spaced than if a commercial crop were being grown. Frequent inspections should be made as soon as the seed has germinated, and any weak or sickly plants, as well as plants with spotted seed leaves, or with blight spots on the leaves or stems, should be carefully removed and immediately destroyed by fire or boiling, the hands then being carefully washed several times in carbolic soap or rinsed in methylated spirits before handling healthy plants. Bean plants should never be worked amongst when any moisture is present on the leaves, as infection may easily be spread in this way.

The plants being grown for seed purposes should be sprayed frequently with 4-4-50 Zinc Bordeaux Mixture, prepared in the usual way except that half of the copper sulphate normally used is replaced by an equal weight of zinc sulphate. (See Leaflet 314.)

Growers whose crops are infected should burn all diseased plants, and should not plant the infected land to any susceptible variety of beans for at least three years.

Regarding varietal susceptibility, Dr. R. J. Noble, Biologist, Department of Agriculture, New South Wales, in a letter to the writer dated 13th November, 1931, says—

"Bacterial blight of bean has been very prevalent in this State during the last two seasons, and at present is so widespread in Canadian Wonder crops that only limited supplies of beans are reaching the market. The disease first came under notice in this State in 1928.

"Field observations have been made by this Department on relative resistance in about 200 varieties and selections of beans for two seasons, *but no variety has shown outstanding resistance.*

"*Kentucky Wonder* and *Epicure* pole beans have been among the most resistant.

"Most lots of Canadian Wonder bean seed on the New South Wales market at present are infected to a greater or lesser extent, but most of the fancy beans are blight-free so far . . . . . It is understood that most of the seed of the fancy types is imported from overseas.

"It is considered that beans will continue to be a very unsafe crop until disease-free seed can be raised."

Mr. D. B. Adam, formerly Plant Pathologist of the Victorian Department of Agriculture, now Plant Pathologist to the Waite Agricultural Research Institute, Adelaide, in a letter to the writer dated 16th November, 1931, advises that—

" . . . . . field observations suggest that the green bush beans 'Pale Dun' and 'Feltham's Prolific' are more resistant to bacterial blight than the 'Canadian Wonder.' The green bean trade is not so keen on these varieties because the pods in the case of 'Pale Dun' are smaller, and in the case of 'Feltham's Prolific' less fleshy than those of 'Canadian Wonder.'

"Among waxpod or butter beans we find that the 'Startler,' though certainly not immune from bacterial blight, is fairly resistant."

Observations made by the writer at Geraldton several years ago amply bore out the contention that "Feltham's Prolific" is much more resistant to "Halo Blight" than "Canadian Wonder." Double rows of seed had been planted, the right hand side being of the one variety and the left hand side being of the other. The seeds of each variety were planted only about 3 inches apart so that the two varieties grew up intimately mixed together. The "Canadian Wonder" were wiped out at a very early age but the "Feltham's Prolific" were a nice deep green colour, grew and yielded well, and although affected to some extent on the leaves, stems and pods, picked a very satisfactory commercial crop.

The white-seeded runner bean which appears to be nameless, but which is so commonly grown at Balcatta, Wanneroo, Osborne Park, and other parts of the metropolitan area and adjoining districts nowadays, has saved the situation in this State, as it appears to be absolutely immune, no plant of this variety ever having been seen by the writer carrying lesions, even when grown alongside crops of "Canadian Wonder" which have been wiped out, or planted on heavily infected land. This bean is not as early maturing as the "Canadian Wonder," but in every other respect provides a satisfactory substitute.

In conclusion, I cannot too strongly emphasise that unless growers can obtain absolutely disease-free seed (as, for example, seed certified by a Government Department of Agriculture to be blight-free), and plant it on disease-free soil, they would be very well advised to give up growing "Canadian Wonder" beans altogether, and confine their attention to the other varieties mentioned above as being somewhat resistant or immune.

A COMPARISON OF THE "WHOLEMEAL FERMENTATION TIME" TEST AND FARINOGRAPH TEST FOR FLOUR QUALITY.

L. W. SAMUEL,
Cereal Research Officer.

Of recent years two tests for the baking quality of wheat and flour that have received considerable attention are: 1, the wholemeal fermentation time test, or Pelshenke test; and 2, the Farinograph.

METHODS.

1. The wholemeal fermentation time test was described by Pelshenke (1930-31) and by Cutler and Worzella (1931), and since then numerous workers have reported the results of its application to the evaluation of the baking quality of wheat.

For the comparison reported in this paper the test was made in triplicate using 5 g. of meal ground in a Wiley mill with a 1 mm. sieve and using 2.7 mls. of a yeast suspension made by dispersing 10 g. of compressed yeast in 108 mls. of distilled water. The doughballs were immersed in 150 mls. of distilled water in a 250 ml. beaker maintained at a constant temperature of 32 deg. C.

The time taken for the doughball to rise to the surface was always noted as a check on the activity of the yeast and was not more than 15 mins.

Nitrogen was determined by the Kjeldahl method and the factor 5.83 used to convert nitrogen into protein which was then expressed on a 13.5 per cent. moisture basis and used in the calculation of specific protein quality, the time in minutes per gram of protein.

Moisture was determined by drying for one hour at 130 deg. C.

The "time" test thus yields three values, the time in minutes for the first piece to be detached from the doughball, the protein content and the specific protein quality.

2. The Farinograph of the Brabender Elektromaschinen O.H., patented in England by Hankoczy (Brit. Patent 340297, 29/8/29), is essentially a recording dough mixer which records graphically the power necessary to mix a dough of standard maximum consistency and records the change in this power with continued mixing. The type of graph obtained is shown in fig. 1 and from this graph three values were obtained for comparison with the fermentation time test.

(a) The water absorption (corrected to a 13.5 per cent. moisture basis) necessary to form a dough with a maximum consistency of 500 units;

(b) the strength figure of the flour, being the time in minutes for the top of the graph to fall below the maximum consistency of 500 units;

(c) the dough weakening, being the number of consistency units by which the median line of the graph has fallen below the maximum consistency after 10 mins. mixing.

The water absorption was first determined by trial and then in the experiment mixing was continued until the top of the graph had fallen below the maximum consistency line.

MATERIALS.

The wheats used in this investigation were the individual varieties entered in the wheat section of the Royal Agricultural Society's Show, 1937, and were thus of the 1936-37 season. There were 65 entries representing 17 varieties and all were subjected to the wholemeal fermentation time test in the Government Chemical

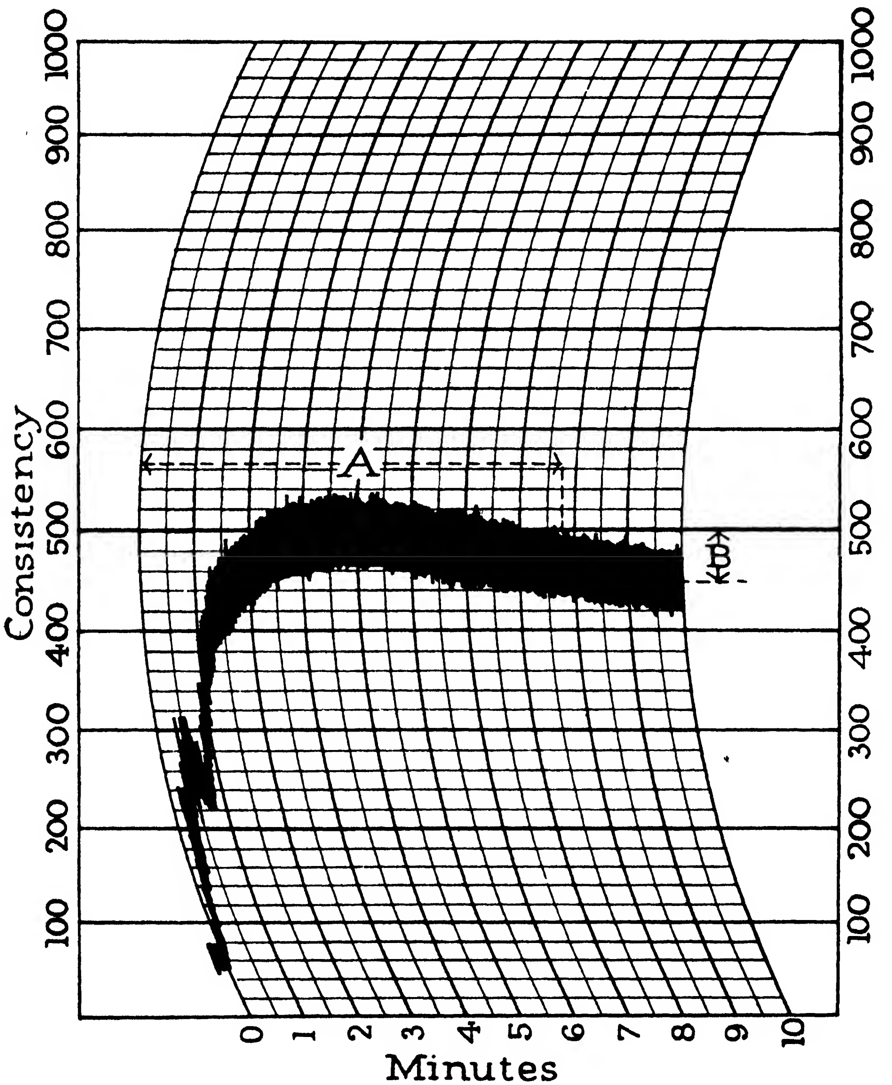


Fig. 1.—Specimen farinogram—A, strength figure; B, dough weakening.

Laboratory. Only 28 of these wheats were milled on the Brabender experimental mill and tested in the Farinograph. The approximate flour extraction was noted and the flours analysed in the Government Chemical Laboratory for moisture, protein, ash and water absorption.

TABLE 1.

Analytical data.

R.A.S. No.	Variety.	Flour Extraction.	Flour Ash.	Protein. Wheat.	Protein. Flour.	Water absorption. Farinograph.	Water absorption. Lapsley.	Farinograph. S.F	Farinograph. D.W.	Fermentation Test. Time.	Fermentation Test. S.P.Q.
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	minutes.		minutes.	
1	Comeback	48·8	0·67	13·6	13·9	67·3	66·0	46·5	0	162	11·9
2	Do.	51·7	0·58	15·0	15·1	67·6	67·0	45·2	0	170	11·3
3	Do.	53·9	0·63	16·1	16·0	67·0	66·5	44·0	0	178	11·1
4	Do.	52·9	0·70	13·1	13·4	64·4	66·0	45·7	0	180	13·7
5	Do.	58·3	0·72	12·3	12·0	64·8	66·0	30·0	0	217	17·6
6	Do.	50·5	0·58	15·2	15·6	68·6	69·0	45·7	0	150	9·9
7	Do.	48·0	0·68	12·1	11·6	69·4	68·5	44·1	0	150	12·4
8	Do.	54·8	0·64	15·5	15·8	67·4	66·5	42·5	0	184	11·9
9	Do.	59·6	0·58	14·7	14·2	65·5	65·0	41·6	0	160	10·9
10	Do.	47·0	0·66	12·1	12·2	68·4	64·5	39·8	0	187	15·4
11	Do.		0·82	14·4	13·7	69·1	66·5	36·5	0	241	17·7
12	Bencubbin			12·1						39	3·2
13	Do.			12·0						54	4·5
14	Do.			12·8						40	3·1
15	Do.			12·7						44	3·5
16	Do.			10·2						33	3·2
17	Do.			11·7						46	3·9
18	Do.	50·5	0·74	11·5	10·0	60·6	55	7·8	60	46	4·0
19	Do.			12·6						60	4·8
20	Do.			11·3						60	5·3
21	Do.			11·4						36	3·2
22	Do.			10·6						43	4·1
23	Do.			9·5						32	3·4
24	Gluyas Early			13·6						36	2·6
25	Totadgin			13·0						32	2·5
26	Do.			15·4						34	2·2
27	Do.	54·4	0·64	12·2	11·0	64·1	54	5·3	110	33	2·7
28	Do.			14·7						43	2·9
29	Do.			12·1						49	4·0
30	Noongaar			11·7						39	3·3
31	Do.			11·1						27	2·4
32	Nabawa			12·8						60	4·7
33	Golden King	54·6	0·57	8·8	7·6	60·0	54·5	8·0	155	26	3·0
34	Merredin			10·3						57	5·5
35	Nabawa	51·9	0·74	11·8	11·1	61·1	54·5	7·1	70	39	3·3
36	Carrabin			13·6						64	4·7
37	Pusa IV.	46·9	0·71	14·6	14·6	71·6	66·5	41·0	0	124	8·5
38	Pusa			13·8						148	10·7
39	Nabawa			12·9						52	4·0
40	Merredin			9·9						47	4·7
41	Do.			7·8						28	3·6

42	Do.	51·9	0·57	11·3	10·2	59 2	55·0	6·5	100	55	4·9
43	Do.			12·4						84	6·8
44	Do.			15 1						52	3·4
45	Gluyas Early	51·6	0·64	11·2	8 3	62·6	54·0	4·3	115	34	3·0
46	Do.			12·6						34	2·7
47	Do.			14 0						52	3·7
48	Do.			12 7						44	3·5
49	Ford	58·7	0·73	9·5	10 0	54 4	56·0	6·5	80	116	12·2
50	Felix	50·0	0·66	11 6	10 5	61 2	55·5	9 25	32	50	4·3
51	Totadgin			8 8						27	3·1
52	Baroota Wonder	58·8	0 68	9 9	8 8	55 6	55 5	4·7	100	45	4·6
53	Flora		0·73	11 8	10 9	67·9	58·0	9·5	21	54	4·6
54	Gresley	58·1	0 67	9 9	8 8	57 8	56·0	5·5	47	52	5·2
55	Felix	44·2	0·66	9 2	8 0	57 9	55·5	5·3	75	48	5·2
56	Sutton	54·9	0 71	11 0	10 4	62 3	57 0	5·0	75	33	3·0
57	Ford	49 7	0 68	12 1	10 9	58 8	57 0	13·3	25	81	6·7
58	Totadgin			12 5						38	3·0
59	Pusa IV.	45 4	0 67	12 1	11 8	68 4	64 0	22 4	0	143	11·8
60	Carrabin			14 4						149	10·4
61	Do.			10 1						58	5·7
62	S.H.J.			9·9						67	6·8
63	Nabawa	42·4	0 63	10·7	9·4	60 5	56·0	8·9	45	54	5·0
64	Do.			8 5						30	3·5
65	Bencubbin			11·0						60	5·4

S.F. Farinograph strength figure. D W. Farinograph dough weakening. S.P.Q. Specific protein quality.

The water absorption was determined by the method described by Lapsley (1924) in which the dough is mixed in a small hand-driven mechanical mixer, and the ability of the dough to stretch between the thumb and forefinger fully extended is taken as indicating the requisite consistency of the dough.

From general experience in the mill and in the bakehouse Western Australian wheats can be classified into two classes, (a) the Premium Strong White Wheats capable of carrying weaker wheats in a blend for bread flours; and (b) the Standard White Wheats which are in general slight y below the strength necessary for a satisfactory bread flour.

COMPARISON OF RESULTS.

The results of the analyses are shown in table 1, expressed on a 13.5 per cent. moisture basis. The flour extraction is calculated on the yield of total products, flour, bran and pollard, and not on the weight of wheat milled. The flour extractions are very low, ranging from 42 per cent. to 60 per cent. and the main factor governing extraction appears to be the speed of milling.

The ash contents are very high, varying from 0.57 per cent. to 0.82 per cent. despite the low flour extraction used.

For seven of the flours the protein content of the flour is higher than that of the wheat and this must be ascribed to sampling errors as separate samples for the two tests were drawn from about a bushel of wheat.

From the data in table 1 a large number of comparisons can be made and these have been done graphically, by plotting each factor against each of the others except that, because there is a very good negative correlation between the farinograph strength figure and the dough weakening, only the comparison of the strength figure with the other factors is discussed here. Similarly there is a very good direct relation between the protein content of the wheat and of the flour derived from it, so that the comparison of only one of these two factors with the other data need be considered here.

Specimen graphs are shown in figs. 2-9.

1. *Flour extraction and flour ash.*

There is no relationship between the extraction and the ash content of the flour for these 28 flours from the Brabender experimental mill.

2. *Flour protein content and wheat protein content.*

As is to be expected there is a good correlation between the protein content of the wheat and of the flour derived from it. There are two anomalies, No. 45 Gluyas Early in which the flour protein is much lower than would be expected and No. 49 Ford in which the flour protein is much higher than would be expected. The average flour protein content is 0.7 per cent. less than the average wheat protein content.

3. *Flour (or wheat) protein content and water absorption.*

(a) Farinograph water absorption.

There is a broad direct relationship between flour (or wheat) protein content and farinograph water absorption enabling an estimate of protein content to within about 1 per cent. to be made from the water absorption. A closer relationship than is found here for individual varieties would be expected for commercial flours milled from a number of varieties.

(b) Water absorption by the method of Lapsley.

The graph of flour protein against Lapsley water absorption separates into two groups of points, group (a) containing the Premium Strong White varieties, and group (b) containing the Standard White varieties.

Group (a) has higher water absorption and strength figures than has group (b) and within each group there is a slight direct relation between protein content and water absorption.

4. *Flour (or wheat) protein content and strength figure.*

The graph of these two factors separates into two groups of points—

(a) containing the Premium Strong White varieties which have the higher strength figures and protein contents. Within this group there is practically no relation between protein content and strength figure.

(b) containing the Standard White varieties. Within this group there is a direct relation between protein content and strength figure which appears to be less marked the higher the protein content.

5. *Wheat protein and fermentation time.*

The points on this graph segregated into two groups by fermentation time, but not by protein content; group (a) containing the Premium Strong White varieties had much longer times, but not necessarily higher protein contents, than did group (b) containing the Standard White varieties.

There is no evidence of a relationship between the two factors either between the two groups or within either group. The sample of "Ford" is anomalous in having a long fermentation time and a low protein content.

6. *Wheat protein and specific protein quality.*

Since there is a good direct relationship between the fermentation time and specific protein quality as will be shown later, the graph of wheat protein against specific protein quality is very similar to that of wheat protein against fermentation time. There is the same segregation into two groups, the same lack of correlation and the variety "Ford" occupies a similar anomalous position.

7. *Water absorption as measured by the Farinograph and by the method of Lapsley* (1924).

The graph of these two factors is again divided into the same two groups of points. Within the Premium Strong White group there is no relationship between the two methods of determining water absorption, and within the group containing the Standard White varieties there is perhaps a slight inverse relationship between the two methods

For 24 of the 28 flours the water absorption as determined by the Farinograph is higher than that determined by the method of Lapsley, and for the 28 flours the average Farinograph water absorption is the higher by 3.1 per cent.

Neither of these two methods has been compared with local bakehouse absorption for any extensive range of water absorptions so that it is not yet possible to decide which of the two methods yields results more comparable with bakehouse practice.

The Farinograph appears to be the more sensitive of the two methods as it has the larger range in water absorption for the flours investigated.

8. *Farinograph water absorption and strength figure.*

The graph of these two factors again segregated into the same two groups of points, group (a) containing the Premium Strong White wheats having higher strength figures and water absorptions than group (b) containing the Standard White varieties. Within group (a) there is no relationship between these two factors, but within group (b) there is a slight direct relationship. The variety "Ford" is anomalous in having a much lower absorption than was indicated by its strength figure.

9. *Farinograph water absorption and fermentation time.*

The points on this graph again formed two groups, group (a) containing the Premium Strong White wheats having higher water absorptions and fermentation times than group (b) containing the Standard White varieties. The variety "Flora" is anomalous in that it has a water absorption comparable with group (a), but a fermentation time comparable with group (b). Within each group there is evidence of an inverse relationship between the two factors. Since the fermentation time test was done with a fixed water absorption the inverse relationship found may in part be the reflection of the effect of the consistency of the doughball on the fermentation time.

10. *Farinograph water absorption and specific protein quality.*

The points on this graph again separated into two groups, group (a) containing the Premium Strong White wheats having higher water absorptions and specific protein quality than group (b) containing the Standard White wheats. The variety "Flora" again occupied an anomalous position with a water absorption comparable with group (a), but specific protein quality comparable with group (b).

Within group (a) there was no evidence of a relationship between the two factors but within group (b) there was an inverse relationship, the lower the specific protein quality the higher the water absorption.

11. *Lapsley water absorption and strength figure.*

The graph of these two factors is again divisible into the same two groups of points, group (a) containing the Premium Strong White wheats having higher strength figures and water absorptions than group (b) containing the Standard White wheats. Within group (a) there is no relationship between the two factors, but within group (b) there is a direct, but not close relationship, the higher the strength figure the higher the water absorption.

12. *Lapsley water absorption and fermentation time.*

The points on this graph again separate into the same two groups, group (a) containing the Premium Strong White wheats having higher water absorptions and fermentation times than group (b) containing the Standard White varieties. Within group (a) there is no relationship between the two factors, but within group (b) there is a direct relation between them, the greater the fermentation time the higher the water absorption.

The variety "Ford" occupies an anomalous position in that its fermentation time approaches that of group (a), but its water absorption is that of group (b).

13. *Lapsley water absorption and specific protein quality.*

The graph of these two factors is very similar to the previous graph as is to be expected from the good relationship between "time" and specific protein

quality. There is the same separation into two groups, the same absence of relationship in group (a) and the same direct relationship in group (b) with the variety "Ford" in a similar anomalous position.

14. *Farinograph strength figure and dough weakening.*

There is a very good inverse relationship between these two factors as it is to be expected that the sooner the top of the graph falls below the maximum consistency (the lower the strength figure) the greater the fall at the end of 10 min. mixing (the greater the dough weakening).

The relationship is not linear and is clouded by the fact that every flour with a strength figure of more than about 12 had necessarily a dough weakening of zero.

15. *Strength figure and fermentation time.*

The points on this graph again separated into the same two groups, group (a) containing the Premium Strong White wheats having higher strength figures and fermentation times than group (b) containing the Standard White wheats.

The sample of "Ford" was anomalous, its "time" approaching that of group (a) but its strength figure being that of group (b).

Within group (a) there is evidence of an inverse relationship between the two factors, but within group (b) there is a good, direct, linear relationship between the two factors.

16. *Strength figure and specific protein quality.*

This graph was very similar to the previous one as is to be expected from the good relationship between fermentation time and specific protein quality. There is the same segregation into two groups, the same anomalous position of "Ford" and within group (a) the same slight inverse relationship. Within group (b) the direct linear relationship is not as good as in the previous graph.

17. *Fermentation time and specific protein quality.*

There is a good direct linear relationship between these two factors as has been noted several times in this laboratory (unpublished data). This good relationship appears to be a mathematical necessity because of the relatively small range in protein content (7.8 per cent to 16.1 per cent.) as compared with the range in fermentation time (27 min. to 241 min.) and in specific protein quality (from 2.1 to 16.9 mins. per g. of protein).

DISCUSSION.

From the data obtained from the two tests, the wholemeal fermentation time test and Farinograph, it is clear that for the wheats examined water absorption, either by the Farinograph or by the method of Lapsley, the strength figure, the dough weakening, the fermentation time or the specific protein quality satisfactorily segregate the Premium Strong varieties Comeback, Pusa IV., S.H.J. and Carrabin from the Standard White varieties. However, the varieties are anomalous in that they are not placed in the same order by each of the above factors.

For the Premium Strong White wheats there is a direct relationship between the protein in the wheat and in the flour derived from it, between the water absorption from the Farinograph or by the method of Lapsley and the flour protein, and between the fermentation time or strength figure and the specific protein quality. There is a slight inverse relationship between the Farinograph water absorption, or strength figure and the fermentation time.

For the Standard White wheats there is a direct relationship between the protein in the wheat and in the flour derived from it, between the Farinograph water absorption and the flour protein, between the fermentation time or strength figure and the specific protein quality and between the fermentation time and the strength figure. There is a slight direct relationship between the flour protein, Farinograph or Lapsley water absorption and strength figure, and between the Lapsley water absorption and flour protein, fermentation time or specific protein quality. There is a good inverse relationship between the strength figure and the dough weakening and a slight inverse relationship between the Farinograph water absorption and the fermentation time or specific protein quality.

There is no relationship between the flour extraction and the flour ash content for the Brabender experimental mill, nor between the protein content of the wheat and fermentation time or specific protein quality nor between the water absorption as determined by the Farinograph and by the method of Lapsley.

Thus the fermentation time and the Farinograph strength figure measure substantially the same factor and each confirms the other as a measure of the baking quality of the flour. Both of these factors are affected by the amount and the quality of the protein content. For very strong wheats or flours, however, the differences between the results by either test are not significant. The few results available indicate that if the fermentation time is greater than 150 mins. or if the strength figure is greater than 24 mins. differences in quality are not significant.

Thus for Western Australian varieties of wheat it appears that either fermentation time or Farinograph strength figure can be used for classification with respect to baking quality. The confirmation of the fermentation time test by the Farinograph is of considerable importance in view of the usefulness of the "time" test in the early stages of wheat breeding.

SUMMARY.

The entries for the Wheat Section of the Royal Agricultural Show, 1937, consisting of 65 samples representing 17 varieties were examined by the wholemeal fermentation time test. Of these, 28 samples, representing 14 varieties, were milled experimentally and the flours analysed and tested in the Farinograph. From the data obtained the wholemeal fermentation time and the Farinograph strength figure measure substantially the same factor in flour quality, but neither factor differentiates satisfactorily between very strong wheats or flours.

The Farinograph water absorption and the protein content of the flour are sufficiently closely related to enable an estimate of the one to be made from a knowledge of the other.

ACKNOWLEDGMENTS.

The writer is indebted to the Government Chemical Laboratory for the determination of the wholemeal fermentation time and for the analyses of the wheats and flours.

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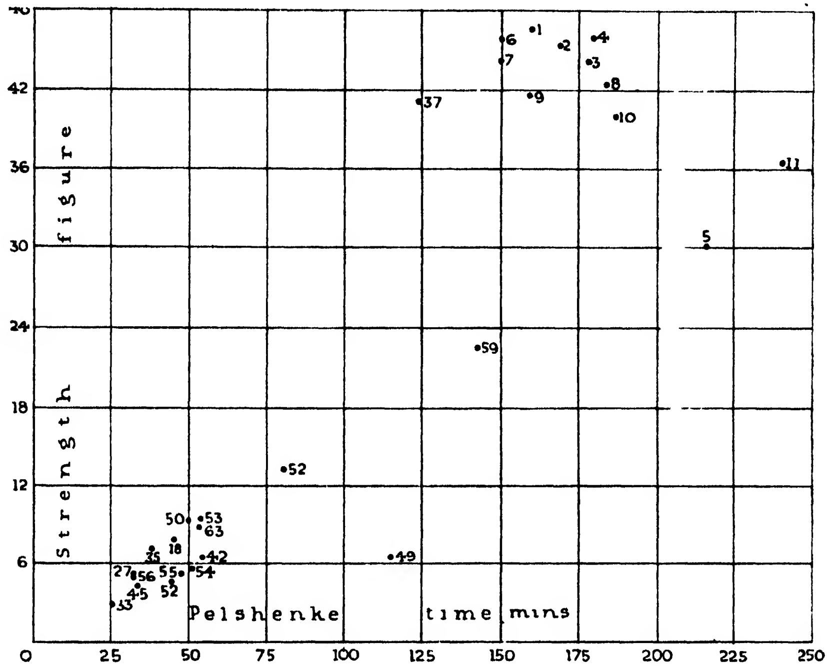


Fig. 2.—Scatter diagram of Pelshenke time and strength figure.

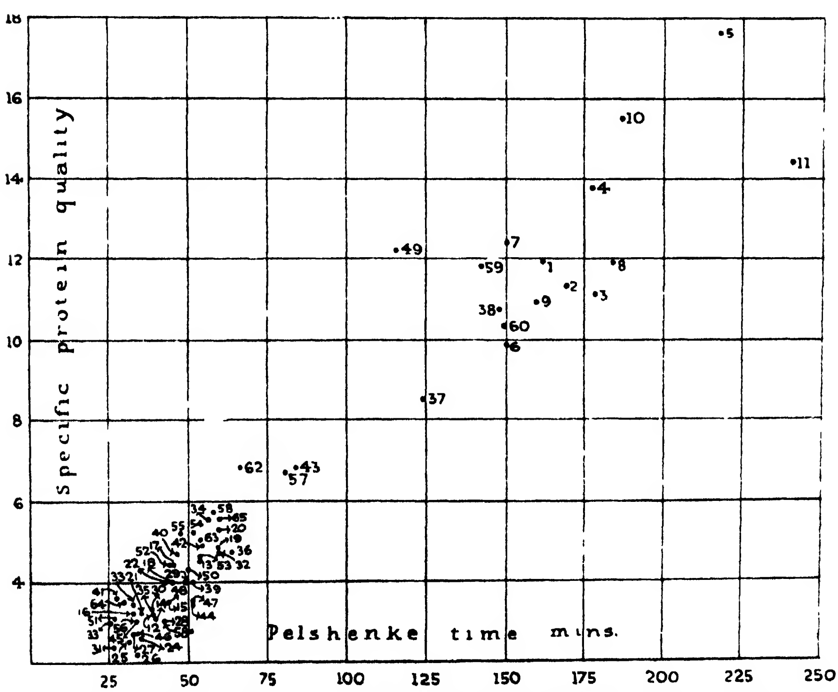


Fig. 3.—Scatter diagram of Pelshenke time and specific protein quality.

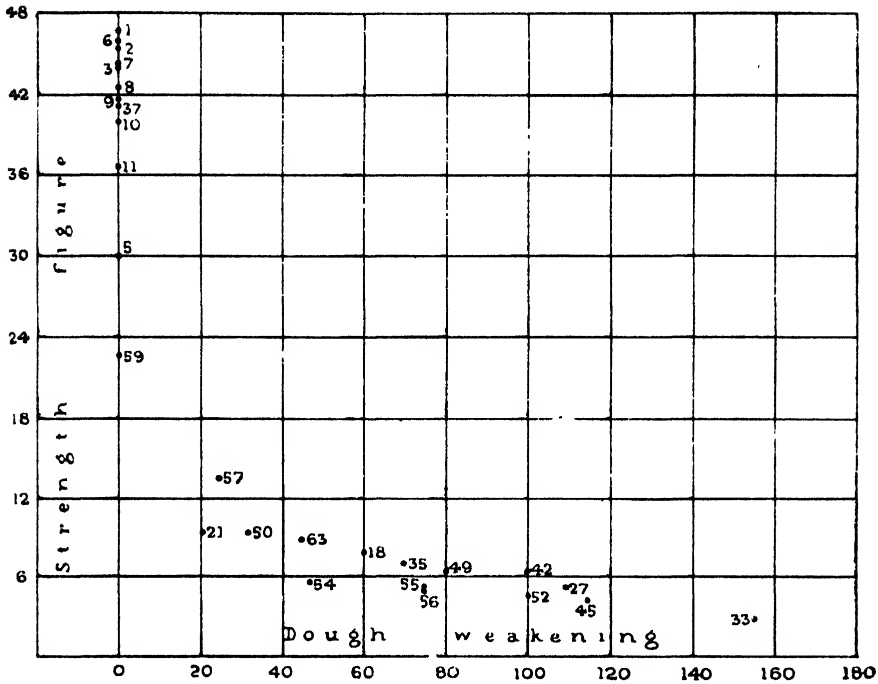


Fig. 4.—Scatter diagram of dough weakening and strength figure.

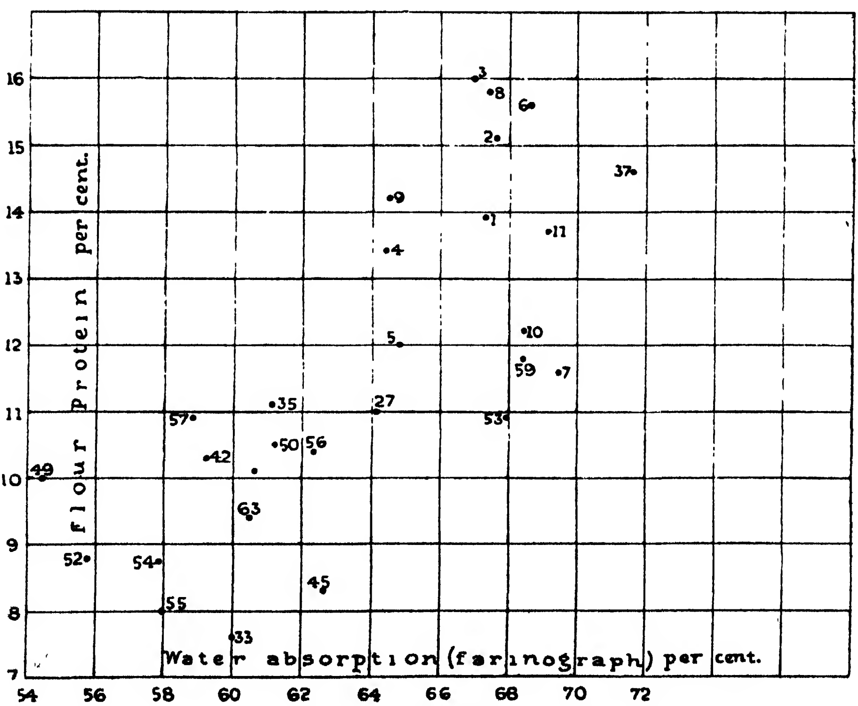


Fig. 5.—Scatter diagram of water absorption and flour protein.

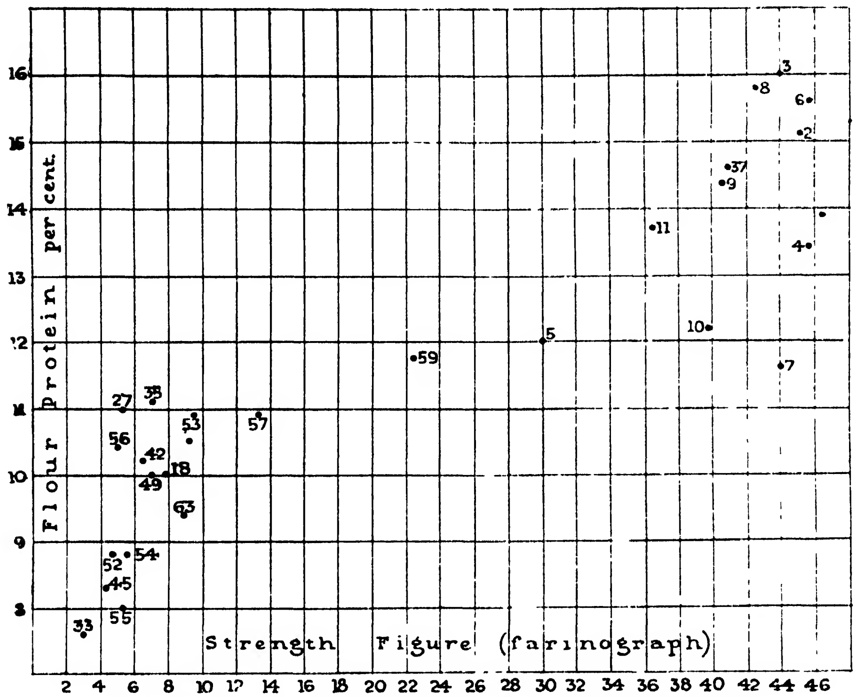


Fig. 6.—Scatter diagram of strength figure and flour protein.

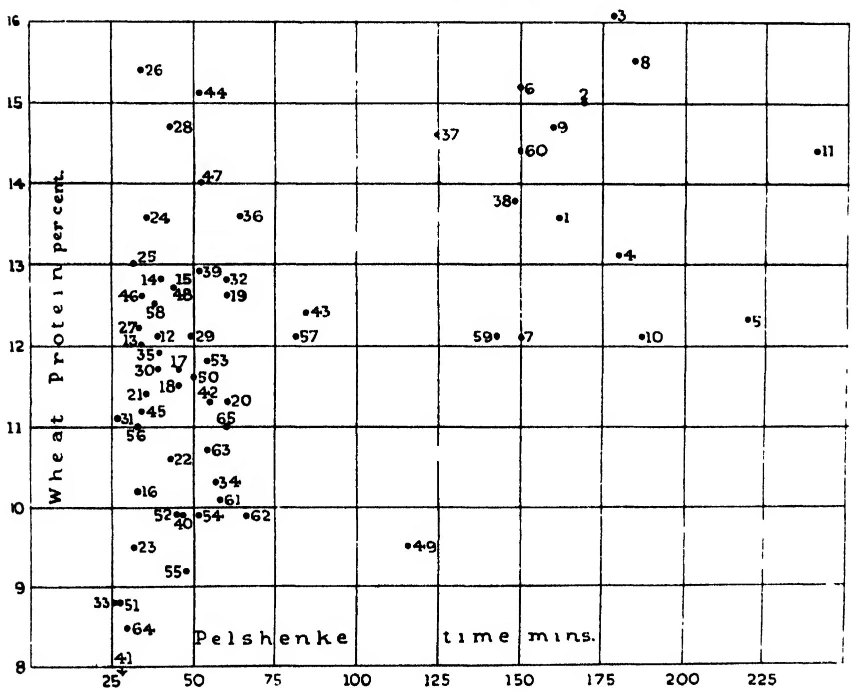


Fig. 7.—Scatter diagram of Pelshenke time and wheat protein.

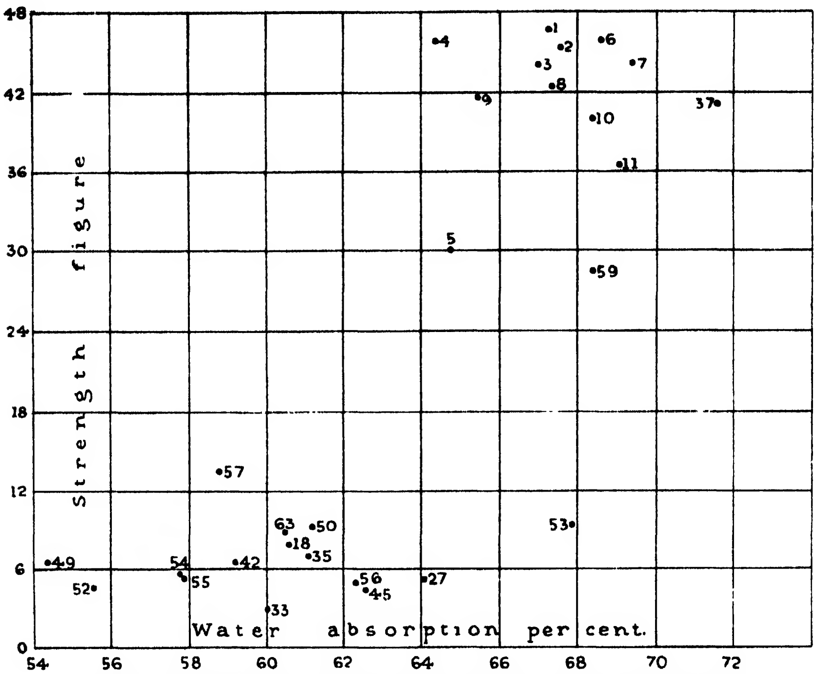


Fig. 8.—Scatter diagram of water absorption and strength figure.

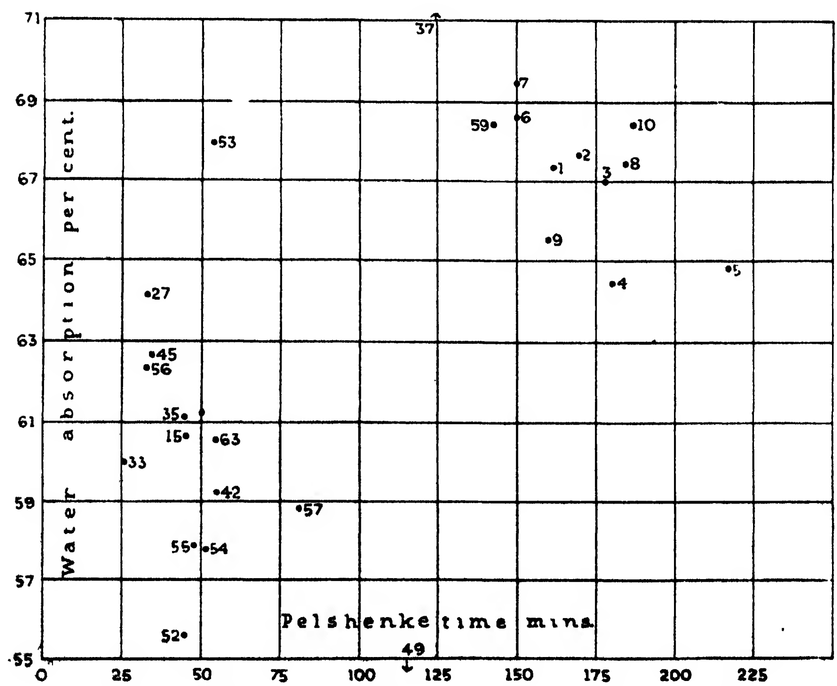


Fig. 9.—Scatter diagram of Pelshenke time and water absorption.

LEAF RUST OF STONE FRUITS.

H. A. J. PITTMAN, B.A., B.Sc. Agr. (Hons.), Dip. Ed.,
Plant Pathologist.

Leaf rust of stone fruits does not usually reach epidemic proportions in Western Australia until fairly late in the autumn. Its main effect is always to cause a premature dropping of the leaves. Towards the end of the season it may become so abundant on the great majority of the leaves of peach, nectarine, almond and plum trees, that the trees may be rendered prematurely dormant. This does not usually occur sufficiently early in the season, however, in commercial orchards, to cause serious under-development in the buds which are to produce the flowers and growth of the following spring, although it may do so under the usually more humid conditions of the backyard orchard. Normally, the disease is not well in evidence until the fruit has been gathered and the buds are well advanced towards maturity.

In the case of some varieties of peaches which ripen very late in the season, the fruits may become attacked and may show small broken blisters from which are liberated the innumerable spores, or seed-structures, of the fungus responsible for the disease. The "Goldmine" nectarine is frequently very seriously attacked on the leaves and also the fruits, especially in the wetter parts of the State, as for example in the Manjimup-Pemberton and other extreme south-western districts. Seedling peaches appear to be more highly susceptible to the disease, as a general rule, than named commercial varieties. Plums are generally less seriously affected in this State than peaches, nectarines and almonds.

In most seasons rust is first noticed about January, thereafter becoming steadily more abundant until the end of autumn. Until recently it has not usually been regarded as a very important disease in this State, but it came very prominently under notice during the past summer and early autumn, being greatly

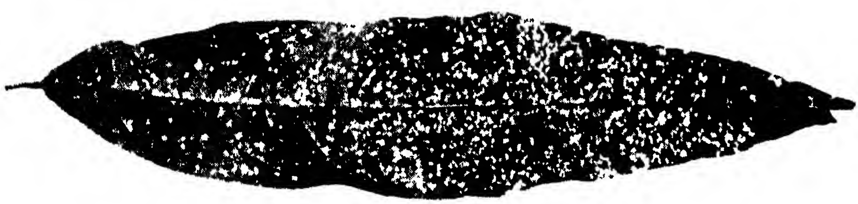


FIG. 1.
Upper surface of Peach Leaf showing yellow spotting due to Rust.
(*Photo N.S.W. Dept. Agric.*)

favoured by the comparatively low temperatures, frequent overcast skies and rather humid weather, with a marked absence of hot, dry easterlies—all of which have been marked features of the fruit season now drawing to a close.

Affected leaves may be recognised by the occurrence of more or less numerous, generally rather angular and straightsided, yellow spots on the upper surface, which contrast quite markedly with the bright green of the still healthy tissues. (Fig. 1.) On the underside, and corresponding with these yellow spots, pustules are developed, which burst and expose dusty masses of minute rust-coloured spores.

(Fig. 2.) The spores (fungal seed-bodies) are the means by which the causal fungus (*Puccinia pruni-spinosae*, Pers.) is blown by the wind, or splashed by rain, or water from sprinklers, from leaf to leaf, or tree to tree, each being a potential source of infection. Two types of spores are produced, known respectively as *uredospores* and *teleutospores*, the former being single-celled and the latter two-celled. Both types are covered with minute spines, whence derives the latter part of the species name of the parasite.

FIG. 2.
Under surface of Peach Leaf showing Rust pustules.
(*Photo N.S.W. Dept. Agric.*)

The lower and older leaves first show signs of the disease, turn yellow and fall prematurely, leaving the upper and younger leaves at the ends of the branches. Peach and nectarine fruits attacked by rust become rough and scabby or spotted with small broken blisters.

The *uredospores* disseminate the fungus rapidly in the summer and autumn, and in warm climate regions serve also to carry the disease over from one autumn to the following spring or summer, but in cold countries, such as England, the *teleutospore* stage brings about infection of species of *Anemone*, *Hepatica* and *Thalictrum*, and it is necessary for reinfection of stone fruits to take place each year, during the growing period, from spores known as *aecidiospores*, which are produced by the infected alternate host. This stage has not been recorded on any of the alternate hosts in this State.

CONTROL.

1. In the late autumn, shortly before the time when the trees normally drop their leaves, spray with home-made Bordeaux mixture 6-4-40 strength, plus ½ lb. Calcium caseinate spray spreader to each 40 gallons of spray. This spray will probably cause the leaves to fall away shortly after spraying, as stone fruit trees, other than apricots, are very sensitive to Bordeaux mixture at any time when the leaves are present. No harm, however, will result to the trees from Bordeaux mixture applied at this time of the year. Information concerning the preparation of home-made Bordeaux mixture will be found in Leaflet No. 314, obtainable free of charge on application, or in pages 410-427 of this Journal for December, 1935.

2. All prunings should be burnt promptly, so as to destroy, as far as possible, the sources of infection for the following season.

3. In the early spring, about a fortnight before any signs of sap movement in the trees may be expected, plough under the green manure crop, together with any fallen fruit tree leaves, then digging-under those parts of the ground which cannot be ploughed, so as to bury the spores with which the leaves and upper regions of the soil may be contaminated. Any subsequent workings of the ground

should be delayed as long as possible, and be as shallow as satisfactory, so as to avoid bringing the leaves and spores to the surface again.

4. In the early pink-bud stage, spray again with 6-4-40 home-made Bordeaux mixture plus ½ lb. Calcium caseinate spray spreader. Further sprayings may not be necessary, but if experience proves them to be required, under the local climatic and other conditions obtaining in the orchard of the grower concerned, they should be as follows:—

5. At the "shuck-fall" stage, spray with liquid lime sulphur 1 part by volume to 100 parts by volume of water, plus ½ lb. calcium caseinate spray spreader to every 50 gallons of spray, or spray with "dry mix sulphur lime," made up as indicated below.

6. 10 days later, dry mix sulphur lime.

7. 2 weeks later than No. 6, dry mix sulphur lime.

8. 3-4 weeks before ripening, dry mix sulphur lime.

Formula for Dry Mix Sulphur Lime.

Sulphur (Commercial Flowers)	8 lbs.
Hydrated lime (finely ground finishing lime)	4 lbs.
Calcium caseinate	½ lb.
or	
Powdered skim milk	½ lb.
Water	50 gallons

The spray outfit is partly filled with water, say one-quarter filled. The ingredients are mixed dry in a tub or barrel and then washed slowly through a fine-mesh wire screen by the force of the water with which the spraying outfit is being filled, the agitator being kept working continuously. Thorough agitation is necessary when using dry mix sulphur lime.

If it is found impracticable to purchase finely ground hydrated lime as such, approximately the right quantity can be prepared by taking 4 lbs. best quality, specially-selected, freshly-burnt spraying lime and carefully slaking it with water in the usual way. When thoroughly slaked, allow to cool somewhat, and then wash through a fine-mesh wire screen into the spray outfit, which has already been about one-quarter filled with water. Keep the agitator going, then wash the other ingredients through the screen and bring up the volume to the correct level before commencing to spray. Four gallons of lime which has been slaked in water at the rate of one pound to the gallon of water, as recommended for the preparation of Bordeaux mixture by the method of stock solutions, may be measured out after thorough stirring, instead of weighing out 4 lbs. of quick lime. (See Leaflet 314 or this Journal, December, 1935, pp. 410-427.)

9. To lessen the ravages of leaf rust on peaches, nectarines, almonds or plums, these should always be grown, in backyard gardens (or elsewhere), in a very sunny situation, and while it may be necessary to apply water at various times during the summer and autumn months, this should be applied in large quantities occasionally, rather than "a little and often," and every effort should be made to keep the humidity of the air in the neighbourhood of the trees as low as possible. Wetting of the foliage by means of a sprinkler is especially to be deplored.

EGG-LAYING TRIALS.

MURESK AGRICULTURAL COLLEGE.

G. D. SHAW,
Poultry Adviser.

The trial just concluded is the second under the new series. This series started on 1st April, 1936. The duration of the trial is for 48 weeks ending on the 2nd of March each year, and there is a break of four weeks between the end of one trial and the beginning of the next. This is to allow for the thorough cleaning of the pens in readiness for the reception of the new birds If at the end of the 48 weeks it is considered that pens of birds may break an existing 12-months record, those pens of birds are retained for the full period of 12 months.

Two hundred and forty birds entered for the trial. All birds are weighed at the beginning of the trial and during the laying period they are checked weighed in order to study the condition. On despatch to the owners at the end of the trial all birds are again weighed.

The management of the trial is in the hands of a committee which consists of the Principal of the College, Mr. H. J. Hughes (Chairman), the Poultry Adviser of the Department of Agriculture, Mr. G. D. Shaw, Mr. S. Dolman, Cranleigh Poultry Farm, and Mr. F. Landquist of York, the two latter gentlemen being the representatives of the competitors. The Committee of Management meet at the College once a month and direct the policy of the trial.

There are 360 pens available and all birds are tested individually, all eggs being weighed daily and the scales used are tested and graduated to one-tenth of an ounce. The College is situated some 60 miles from Perth. The soil is ideal and the conditions good. Heat in summer has at times caused distress, but this factor is now held in check by the growth of lilacs which are in between the rows of the laying pens. The pens are in rows of 84 with a break in the centre of the row.

The conditions governing the trial are as follow:—

COMMITTEE OF MANAGEMENT.

The Committee of Management shall consist of the Principal of the College, the Poultry Adviser, Department of Agriculture, or officers acting in their stead, and two representatives elected by the breeders taking part in the preceding trial.

Note.—The term "breeder" is given to those who have entered birds in the trials.

POWERS OF THE COMMITTEE.

The Committee shall have absolute control of the trials conducted during its tenure of office.

It shall recommend what tests are to be carried out and arrange the conditions and regulations governing the same.

The representatives elected shall take office on 1st April succeeding the date of appointment.

The committee shall meet at such times as it may deem necessary.

The trial shall consist of the following sections:—

Section "A"—Pen of Six Birds—All Light Breeds.
Section "B"—Pen of Six Birds—All Heavy Breeds.
Section "C"—Pen of Six Birds—All Medium Heavy Breeds.

The trial shall extend from 1st April until 2nd March (48 weeks). The leading group or individual bird in each section may be allowed to remain at the College for the full period of twelve months.

Each breeder shall be charged an entrance fee of 5s. per bird, 2s. 6d. per bird to accompany application for pens. The balance of 2s. 6d. per bird is to be forwarded to the Principal, Muresk Agricultural College, within 14 days after notice of allotment of pens; otherwise pens may be allotted to other applicants and the 2s. 6d. application fee forfeited.

For any of the above sections pure-bred birds only must be entered.

All eggs shall be the property of the Muresk Agricultural College.

Each of the pullets will be single tested, housed (semi-intensive), and the individual numbers and weight of eggs will be kept.

REGULATIONS.

1. In each section the trial will be decided by the highest number of first-grade eggs obtained by each group of birds and by each individual bird in their respective sections.

2. Sections "A," "B" and "C."—During the first two months of the trial a first-grade egg shall weigh not less than 1¾ ozs., thereafter during the remainder of the trial a first-grade egg shall weigh not less than 2 ozs.

Second Grade.—The minimum weight of a second-grade egg shall be not more than ¼ oz. less than a first-grade egg. Second-grade eggs will be recorded but not counted.

3. Eggs under 1½ ozs. in weight during the first two months of the trial and under 1¾ ozs. in weight during the remainder of the trial, soft-shelled, or broken will be recorded, but not counted in trial results.

4. In all sections the actual weight of each egg shall be kept.

Note.—The certificate for the winter test, 1st April to 31st July, shall be given subject to Rules 2 and 3.

5. Progress results will be published weekly as far as practicable, and all prizes shall be awarded as soon as possible after the termination of the trial. Results to be reported under breed headings.

6. No protest shall be considered unless received within 14 days of the alleged breach of regulations, and accompanied by a deposit of £1, which deposit shall be returned if the protest is upheld, or forfeited if, after inquiry, the protest is considered to be frivolous or without foundation.

7. Records shall be kept of the average cost per head of food consumed.

8. All birds to be accepted must conform to the following conditions:—

(a) Shall be the property of the breeder.

(b) Must be not less than six months and not more than nine months of age on 1st April.

(c) Must be fair specimens of the breed.

(d) Must weigh not less than—

Section "A"—Light Breeds—	lbs.
Leghorn, Ancona	3¾
Minorca	4

Section "B"—Heavy Breeds—

Australorp	5
Sussex, Langshan	5
Plymouth Rock	5

Section "C"—Medium Heavy Breeds—

Barnevelder	5
Rhode Island Red	5
Wellsummer	4½
Wyandotte	4½

9. All birds sent to the trial must conform with the weight prescribed in the preceding paragraph, otherwise the committee shall cancel the allotment pens, in addition to which the entrance fee may be forfeited.

10. All birds shall be treated for vermin and delivered at the Muresk Agricultural College, Muresk, between 27th March and 31st March, inclusive, in new coops or crates, with the breeder's name and address clearly stencilled or painted thereon. Entries will not be accepted from any person whose premises are tick-infested or whose flock is suffering from any infectious or contagious disease.

11. Freight to the College is to be prepaid or delivery will not be accepted. Freight on rejected birds must be paid by the breeder.

12. All birds must be ringed with the numbered leg bands supplied and forwarded free to the breeder. These will correspond with the number of the pens allotted.

The pens having overhead netting, it is unnecessary to cut any bird's wing feathers.

13. The Poultry Adviser, or his representative, shall have the power to reject any bird which in his opinion is not of the correct age, or which he considers does not conform in any way to rule 9, and his decision shall be final.

14. Any bird found to be suffering from an infectious or contagious disease, or with crooked breasts, or side sprigs in combs will be rejected and returned, and shall be replaced by a suitable one within seven days after the notification of same. If any bird is found infested with tick the group will be rejected, the entry cancelled, and the entry fee forfeited.

15. In the event of a bird during the course of the trial becoming diseased, incapacitated from laying, or developing vicious habits (such as egg-eating or feather-eating) it may be returned, or, on the written authority of the owner, destroyed.

Should this occur, the breeder may replace it with another bird of the same age and breed; in the case of a bird dying, replacement may be made. Any score standing to the credit of a bird which is replaced shall be struck out.

16. No breeder shall withdraw any bird until the termination of the trial, except as provided in rule 15.

17. The committee reserves to itself the right to inspect or to have inspected any applicant's stock with a view to determining whether the quality and character of the birds warrant the allotment of pens.

18. (a) Any breeder taking part in the current trial will have the right of allotment of one pen of six birds per section in the succeeding trial. After such allotment new applications will have the right of allotment of one pen of six birds per section. Should there then be any vacant pens they will be allotted by ballot to any applicant.

(b) If after the allotment of pens it is ascertained that incorrect information has been furnished the allotment may be cancelled and the birds returned. In such case the entrance fee shall be forfeited and the applicant may be debarred from entry to any future trial.

19. Any breeder violating or failing to conform to these regulations shall be subject to such disqualification as the committee may decide.

20. Where there is a tie for any place, the award shall be given to the breeder whose bird or group (as the case may be) lays the greater total weight of first-grade eggs.

21. While every care will be taken, the committee will not be responsible for loss or injury to any birds in any way in connection with the trial.

22. The committee may disqualify any breeder and may refuse entry to subsequent trials where such breeder publishes in any way statements of records not in accordance with the official records of the trials.

23. The committee's decision in all matters shall be final.

PRIZES.

Note.

Certificates will accompany all prizes.

No prizes shall be awarded in any section unless there are at least three entries. No second prize will be awarded unless there are at least four entries.

CHAMPION CERTIFICATE.

A champion certificate will be awarded to the group pen from sections "A" and "B" and "C" obtaining the highest total of first-grade eggs during the term of the trial.

GOVERNMENT STANDARD CERTIFICATE.

A Government standard certificate and a registered sealed copper ring will be awarded to all birds laying not less than 200 first-grade eggs or over during the term of the trial.

DISCUSSION.

Some explanation with reference to the classes may not be out of place. In the schedule it will be noticed that light, heavy, and medium-heavy classes are defined by weight. This is not a clear interpretation of the classes. It has been found that the activity of the different breeds vary, so much so that the feeding of light birds must be on a different plane to the feed given to the heavy. It was found that the food giving the best results for light breeds was too fattening for the heavy breeds. This was because the heavy breeds were not as active as the light and therefore did not utilise the carbohydrates to the best advantage. Hence the heavy breeds are fed on a narrower ration than are the light breeds.

Again, the breeds placed into what is described as medium-heavy are not necessarily lighter in weight than are the heavy breeds, but those placed in the medium-heavy class are more active than those breeds placed in the heavy class, yet not as active as those of the light breeds quoted. Hence the rations suitable for the medium-heavy breeds should be wider than that given for the heavy breeds but narrower than that given to the light breeds. This has been satisfactory and

the feeding at the laying trial is based on the article on "Feeding" published in the *Journal of Agriculture,* September, 1934, pages 435 onwards, and in the December, 1936, *Journal,* pages 465 onwards. This system of feeding had allowed the birds the necessary requirements of protein and carbohydrates consistent with their activities and the noticeable factor at the completion of each trial of the second series has been that the birds have been returned to their owners in good condition, each bird having put on weight during the period, but no bird has carried superfluous fat.

Australorps again proved their superiority over the White Leghorns. There is need for alarm at such a result, but the breeders are alive to the shortcomings and the trial for 1938-39 should show a marked improvement in production.

The following are the results at the completion of the trial on 2nd March, 1938:—

SUMMARY.

Teams of Six Birds.

Section "A"—Light Breeds—Westralian Farmers' Cup and Replica—
E. E. Price. Score—First-grade, 1,257. Second-grade, 30.

Section "B"—Heavy Breeds—W.A. Produce Auctioneers' Cup and Replica—
M. H. Dadley. Score—First-grade, 1,488. Second-grade, 54.

Section "C"—Medium-Heavy Breeds—Ian Hazlett Cup and Replica—
R. Harrison. Score—First-grade, 1,172. Second-grade, 15.

Teams Entered by Returned Soldiers—

Light Breeds—R.S.L. Trophy—
Webb's Hatchery. Score—First-grade, 1,099. Second-grade, 151.

Heavy Breeds—R.S.L. Trophy—
M. H. Dadley. Score—First-grade, 1,488. Second-grade, 54.

Medium-Heavy Breeds—R.S.L. Trophy—
R. Harrison. Score—First-grade, 1,172. Second-grade, 15.

Winter Test (Teams of Six Birds—1st April to 31st July).

Section "A"—Light Breeds—Western Ice Trophy—
H. P. Chalmer. Score—First-grade, 415. Second-grade, 11.

Section "B"—Heavy Breeds—Western Ice Trophy—
M. H. Dadley. Score—First-grade, 535. Second-grade, 2.

Section "C"—Medium-Heavy Breeds—Western Ice Trophy—
R. Harrison. Score—First-grade, 485. Second-grade, nil.

Highest Score First-Grade Eggs.

Light Breeds—

First Prize—McFarlane Cup and Replica—
H. P. Chalmer, Bird No. 4. Score—First-grade, 243. Second-grade, 2.

Second Prize—James Goss Trophy—
Webb's Hatchery, Bird No. 78. Score—First-grade, 240. Second-grade, 21.

Heavy Breeds—

First Prize—Bairds Cup and Replica—

W. & E. Kerr, Bird No. 167. Score—First-grade, 267. Second-grade, 1.

Second Prize—Barrow Linton Trophy—

*M. H. Dadley, Bird No. 57. Score—First-grade, 265. Second-grade, 0.

Medium-Heavy Breeds—

First Prize—Enston Cup and Replica—

Cranleigh Poultry Farm, Bird No. 104. Score—First-grade, 211. Second-grade, 31.

Second Prize—Harrold & Murray Trophy—

†R. Harrison, Bird No. 114. Score—First-grade, 206. Second-grade, 1.

First Bird to Lay 200 First-Grade Eggs.

Light Breeds—T. Newby Trophy—

Webb's Hatchery, Bird No. 78, on December 21st, 1937.

Heavy Breeds—Bateman Trophy—

M. H. Dadley, Bird No. 60, on November 16th, 1937.

Medium-Heavy Breeds—Spearwood Branch P.P.A. Trophy—

Cranleigh Poultry Farm, Bird No. 104, on January 25th, 1937.

DETAILED RESULTS.

SECTION "A" (LIGHT BREEDS)—TEAMS OF SIX BIRDS.

Name of Competitor and Birds Nos.	1st.	2nd.	1st.	2nd	1st.	2nd.	1st.	2nd.	1st.	2nd.	1st.	2nd	Totals 1st.	Totals 2nd.
H. P. Chalmers—1—6	147	37	224	1	141	3	243	2	189	1	208	33	1152	77
E. E. Price—7—12	196		200	28	221		182	2	222		236		1257	30
Thorpe P.F.—13—18	40	172	28	120	128	28	201	3	108	128	148	44	653	504
F. B. Vickers—19—24	213	4	173	4	216	5	195	7	78	52	37	164	912	236
Mrs M. H. Dadley—25—30	127	4	220	1	111	19	194	1	234	5	166	1	1052	31
M. H. Dadley—31—36	192	2	141	1	199	12	152	37	180	27	228		1092	79
R. Harrison—37—42	158	4	230	2	169	1	204	21	155	29	179	9	1095	66
J. Duncan—43—48	190	7	216		171	4	174	1	177		167	4	1095	16
N & V. Trimble—49—54	115	42	194	17	178	2	92	74	169	27	174	42	922	204
R. Lowe—55—60	172	9	143	3	190	30	153	22	176	1	173	13	1007	78
Mrs R. Lowe—61—66	162	11	133	39	133	27	207	19	138		158	13	931	109
E. Singleton—67—72	135		174	6	182	57	168	74	172	27	135	1	966	165
Webb's Hatchery—73—78	229	13	171	41	192	19	118	5	149	52	240	21	1099	151
Cranleigh P.F.—79—84	159	74	99	5	59	105	139	50	151	23	122	53	729	310
Runnymede P.F.—127—132	109	81	45	158	193	8	26	170	189	56	176	32	738	505
C. C. Lewis—133—138	194	45	69	178	136	53	121	43	192	17	129	52	841	388

* M. H. Dadley—Bird No. 57: Score 1st Grade 265; 2nd Grade —

Runnymede P. Farm—Bird No. 8: Score 1st Grade 265; 2nd Grade 3.

Under regulation total weight of 1st Grade eggs showed:—Bird No. 57 = 609 ozs.; Bird No. 8 = 576 ozs.

† R. Harrison—Bird No. 109: Score 1st Grade 206; 2nd Grade 2.

R. Harrison—Bird No. 112: Score 1st Grade 206; 2nd Grade 2.

R. Harrison—Bird No. 114: Score 1st Grade 206; 2nd Grade 1.

Under Regulation 21 total weight of 1st Grade eggs showed:—Bird No. 109 = 456 ozs.; Bird No. 112 = 455 ozs.; Bird No. 114 = 487 ozs.

DETAILED RESULTS—*continued.*

SECTION "B" (HEAVY BREEDS)—TEAMS OF SIX BIRDS.

Name of Competitor and Birds Nos.	1st	2nd.	1st	2nd	1st	2nd	1st.	2nd.	1st.	2nd.	1st.	2nd.	Totals. 1st.	Totals. 2nd.
G. Davey & Sons— 1—6	249	12	200		165	11	139	6	224	42	204	5	1181	76
Runnymede P.F.— 7—12	189	2	265	3	241	2	214	3	243	6	154	55	1306	71
A. Hampton (No. 1)— 13—18	141	1	182	56	73	12	166	31	154	.	206	4	922	104
A. Hampton— 19—24	199	21	253	1	231	2	201	26	152	63	239	7	1275	120
Hilltop P.F.— 25—30	172	43	95	32	175	3	203	11	132	28	93	5	870	122
E. E. Price 31—36	219	5	194	20	203		178	43	127	105	107	1	1028	174
Thorne P.F.— 37—42	211		217	1	168		262		203	4	192	40	1253	45
G. W. Barker— 43—48	116	45	171	55	221	12	202	3	218	2	192	28	1120	145
Mrs. M. H. Dadley— 49—54	238	1	125	.	223	5	49	220	203	79	189	.	1027	305
M. H. Dadley— 55—60	244	1	231	2	265		254	2	250	6	244	43	1488	54
Robinson Bros.— 61—66	86		166	2	180		93		227		230	5	982	7_
R. Harrison— 67—72	257	11	192	4	192	53	226		261	19	211		1339	87
A. S. Webb— 73—78	170	25	207	1	169	4	169	4	117	12	140	1	972	47
M. Wall— 79—84	205	24	220	16	176	32	245	1	162	4	247	2	1255	79
Wyndella P.F.— 145—150	176	2	176	10	264		134		221	.	179	1	1150	13
Cranleigh P.F.— 151—156	211	12	171	.	215	12	231		178	20	16		1022	44
F. Landquist & Son— 157—162	74	47	145	27	133	26	25	158	169	17	105	61	651	336
W. & E. Kerr— 163—168	218	13	197		171	1	260	1	267	1	206		1319	16

SECTION "C" (MEDIUM HEAVY BREEDS)—TEAMS OF SIX BIRDS.

Name of Competitor and Birds Nos.	1st.	2nd.	1st.	2nd.	1st	2nd	1st.	2nd.	1st.	2nd.	1st.	2nd.	Totals 1st	Totals 2nd
F. B. Vickers— 85—90	21		186	45	104	118	188	29	164	73	199	18	862	283
F. Landquist & Son— 91—96	25	139	185	15	110	72	120	8	137	1	146	5	723	240
Hilltop P.F.— 97—102	155	53	74	70	77	62	135	21	105	62	109	8	655	276
Cranleigh P.F.— 103—108	54	64	211	31	198		146	4	190	2	171	53	972	154
R. Harrison— 109—114	206	2	183		198	10	206	2	173		206	1	1172	15
Runnymede P.F.— 115—120	173	1	51	19	90	1	174		156	3	133	30	777	54

Mortality.

The following is a comparison of the deaths for 1936-37 and 1937-38:—

	1936/37. Deaths.	1936/37. %	1937/38. Deaths.	1937/38. %
White Leghorns	6	6	7	7·3
Australorps	6	5·36	8	7·1
Rhode Island Reds	2	5·7	3	8

Note.—Two egg-eaters in 1937/38 were condemned and replaced.

Averages.

MONTHLY AVERAGES.

Month.	Breed.	Total No. of 1st Grade Eggs Laid.	Average.	Total No. of 2nd Grade Eggs Laid.	Average.	Total Average for all Grades.
April	W.L.	1016	10·58	255	2·65	13·23
	Aus.	1586	14·68	106	·98	15·66
	R.I.R. ...	420	11·6	31	·86	12·46
May	W.L.	1167	12·15	68	·70	12·85
	Aus.	1908	17·66	30	·27	17·93
	R.I.R. ...	554	15·38	9	·25	15·63
June	W.L.	983	10·23	175	1·82	12·05
	Aus.	1663	15·39	188	1·74	17·13
	R.I.R. ...	499	13·86	115	3·19	17·05
July	W.L.	1323	13·78	137	1·42	15·20
	Aus.	2039	18·87	116	1·07	19·94
	R.I.R. ..	458	12·72	65	1·80	14·52
August ...	W.L.	1824	19·0	145	1·51	20·51
	Aus.	2267	20·99	131	1·21	22·20
	R.I.R. ...	648	18·0	72	2·0	20·0
September ...	W.L.	1975	20·57	149	1·55	22·12
	Aus.	2314	21·62	162	1·51	23·13
	R.I.R. ...	601	16·69	114	3·16	19·85
October ...	W.L.	1987	20·69	280	2·90	23·59
	Aus.	2074	19·56	203	1·91	21·47
	R.I.R. ...	566	15·72	118	3·26	18·98
November ...	W.L.	1715	18·05	382	4·02	22·07
	Aus.	1889	17·99	243	2·31	20·30
	R.I.R. ...	437	12·48	148	4·22	16·70
December ...	W.L.	1442	15·50	469	5·04	20·54
	Aus.	1682	16·17	223	2·14	18·31
	R.I.R. ...	370	10·57	124	3·54	14·11
January ...	W.L.	1188	12·91	510	5·54	18·45
	Aus.	1422	13·80	246	2·38	16·18
	R.I.R. ...	307	9·02	120	3·52	12·54
February ...	W.L.	922	10·02	394	4·28	14·30
	Aus.	1316	12·90	197	1·93	14 83
	R.I.R. ...	301	8·85	106	3·11	11·96

YEARLY AVERAGES.

	1st Grade.	2nd Grade.	Average All Grades.
White Leghorns	163.68	31 13	194 81
Australorps	189.97	17.38	207.35
Rhode Island Reds	145.53	28.82	174.35

WINTER TEST RESULTS.

April 1st July 31st (122 days).

Winners.	No. of Eggs.	Average 1st Grade Eggs.
Light Breed—H. P. Chalmer—White Leghorns	415	69.1
Heavy Breed—Mr. M. H. Dadley—Australorps	535	89.1
Medium-Heavy—R. Harrison—Rhode Island Reds ..	485	80.8

LAYING AVERAGES FOR WINTER TEST.

April 1st–July 31st (122 days).

	1st Grade.	2nd Grade.	Average All Grades.
Light Breeds—Leghorns	46.76	6.61	53.37
Heavy Breeds—Australorps ..	66.53	4.07	70.7
Medium-Heavy—Rhode Island Reds	53.63	6.11	59.74

DISCUSSION.

The results for 1937-38 are in every class higher than for the previous trials. It will be noticed also that the numbers laid by the first ten leading teams in each of the light and heavy breed sections are far ahead of the numbers laid in the preceding trial.

	1936/37.		1937/8.	
	1st	2nd	1st	2nd
10 pens White Leghorns ..	960.8	21.7	1,074.6	8.06
10 pens Australorps	1,128.6	12.11	1,268.6	7.06
*5 pens Rhode Island Reds ..	798.2	220.	901.2	149.1

*Rhode Island Reds entered for 1936/37 consisted of five pens of six birds, while in 1937/38 six pens were entered.

The above figures are remarkable. The improvements in one year give hope for a continued advance in the breeding for the large egg.

Section "A" (White Leghorns) improved by 114 first-grade eggs per pen of six birds. The second-grade eggs, although not counted but recorded, show that the White Leghorns have improved also in egg size.

Section "B."—The most prominent advance has been that of the Australorps, which have improved their pen average by 140 first-grade eggs. Here again the second-grade eggs have decreased.

Section "C."—The Rhode Island Reds have also shown improvement on the 1936-37 figures. Not only has the number of first-grade increased by 103 eggs, but the number of second-grade has decreased by 71 eggs per pen. There is room for a marked improvement in this breed. The number of eggs under 2 ozs. in weight is too high. It is hoped that an improvement will take place during the term of the current trial.

The following birds which laid 200 or more first-grade eggs during the 48 weeks were awarded a sealed copper ring:—

COPPER-BANDED BIRDS.

Copper Band No.	Trial No.	Breed.	Owner.	Number 1st Grade Eggs.
50	1	Australorp	G. Davey & Sons ..	249
51	2	Australorp	G. Davey & Sons .	200
52	5	Australorp	G. Davey & Sons ..	224
53	6	Australorp	G. Davey & Sons ..	204

Copper-banded Birds—*continued.*

Copper Band No.	Trial No.	Breed.	Owner.	Number 1st Grade Eggs.
54	8	Australorp	E. O. Harrison ..	265
55	9	Australorp	E. O. Harrison ..	241
56	10	Australorp	E. O. Harrison ..	214
57	11	Australorp	E. O. Harrison ..	243
58	18	Australorp	A. Hampton	206
59	20	Australorp	A. Hampton	253
60	21	Australorp	A. Hampton	231
61	22	Australorp	A. Hampton	201
62	24	Australorp	A. Hampton . ..	239
63	28	Australorp	A. W. Gregson ..	203
64	31	Australorp	E. E. Price	219
65	33	Australorp	E. E. Price	203
66	37	Australorp	H. Seal	211
67	38	Australorp	H. Seal	217
68	40	Australorp	H. Seal . ..	262
69	41	Australorp	H. Seal . ..	203
70	45	Australorp	G. W. Barker ..	221
71	46	Australorp	G. W. Barker ..	202
72	47	Australorp	G. W. Barker ..	218
73	49	Australorp	Mrs. M. H. Dadley ..	238
74	51	Australorp	Mrs. M. H. Dadley ..	223
75	53	Australorp	Mrs. M. H. Dadley ..	203
76	55	Australorp	M. H. Dadley ..	244
77	56	Australorp	M. H. Dadley ..	231
78	57	Australorp	M. H. Dadley ..	265
79	58	Australorp	M. H. Dadley ..	254
80	59	Australorp	M. H. Dadley ..	250
81	60	Australorp	M. H. Dadley .	244
82	65	Australorp	Robinson Bros. ..	227
83	66	Australorp	Robinson Bros. ..	230
84	67	Australorp	R. Harrison	257
85	70	Australorp	R Harrison	226
86	71	Australorp	R. Harrison	261
87	72	Australorp	R. Harrison ..	211
88	74	Australorp	A. S. Webb	207
89	79	Australorp	M. Wall	205
90	80	Australorp	M. Wall	220
91	82	Australorp	M. Wall . ..	245
92	84	Australorp	M. Wall .. .	247
93	147	Australorp	D. F. Robinson ..	264
94	149	Australorp	D. F. Robinson ..	221
95	151	Australorp	S. Dolman	211
96	153	Australorp	S. Dolman . ..	215
97	154	Australorp	S. Dolman	231
98	163	Australorp	W. & E. Kerr ..	218
99	166	Australorp	W. & E. Kerr ..	260
100	167	Australorp	W. & E. Kerr ..	267
101	168	Australorp	W. & E. Kerr ..	206
102	104	Rhode Island Red	S. Dolman	211
103	109	Rhode Island Red	R. Harrison	206
104	112	Rhode Island Red	R. Harrison	206
21	2	White Leghorn	H. P. Chalmer ..	224
22	4	White Leghorn	H. P. Chalmer ..	243
23	6	White Leghorn	H. P. Chalmer ..	208
24	8	White Leghorn	E. E. Price	200
25	9	White Leghorn	E. E Price	221
26	11	White Leghorn	E. E. Price . ..	222
27	12	White Leghorn	E. E. Price	236

Copper banded Birds—*continued.*

Copper Band No.	Trial No.	Breed.	Owner.	Number 1st Grade Eggs.
28	16	White Leghorn	H. Seal	201
29	19	White Leghorn	F. B. Vickers	213
30	21	White Leghorn	F. B. Vickers	216
31	26	White Leghorn	Mrs. M. H. Dadley	220
32	29	White Leghorn	Mrs. M. H. Dadley	234
33	36	White Leghorn	M. H. Dadley	228
34	38	White Leghorn	R. Harrison	230
35	40	White Leghorn	R. Harrison	204
36	41	White Leghorn	J. Duncan	216
37	64	White Leghorn	Mrs. R. Lowe	207
38	73	White Leghorn	W. R. Webb	229
39	78	White Leghorn	W. R. Webb	240
105	114	Rhode Island Red	R. Harrison	206

In 1936-37 69 birds qualified, while in 1937-38 75 birds gained the distinction. The percentage of copper rings gained in 1936-37 was 27.5 while in 1937-38 the percentage rose to 30 per cent., an increase of 2½ per cent.

The champion team was a pen of Australs entered by Mr. M. H. Dadley, of Coogee, via Fremantle. The total of 1,488 first-grade eggs was 195 higher than the leading team of 1936-37. It will be noticed that every bird in the team qualified for a sealed copper ring.

Mr. E. E. Price, of Hilton Park, via Fremantle, won in the White Leghorns section. His team laid 1,257 first-grade eggs, this being 38 in advance of last year's winners.

In Rhode Island Reds, Mr. R. Harrison, of Inaloo, Scarborough, won with a team laying 1,172 first-grade eggs. This was 40 eggs better than the year 1936-37.

Feeding.

In addition to the trial birds being tested at the College, the Poultry Branch of the College were testing breeders for their own use and therefore the feed used at the trials must be considered as having been fed to 271 birds in 1936-37 and 248 birds in 1937-38.

Feed Consumed.	1936/37.		1937/38.	
Wheat	190½	bushels.	165½	bushels.
Pollard	186	„	191	„
Wheat Meal	6,798	lbs.	6,469	lbs.
Meat Meal	1,700	lbs.	1,962	lbs.
Bran	207	bushels.	178	bushels.
Bonemeal	747	lbs.	990	lbs.
Salt	84	lbs.	84	lbs.
	= 5·14 ozs. per fowl per day.		= 5·13 ozs. per fowl per day.	

It is noticed—

(1) That the wheat feeding is less in 1937-38 than in 1936-37; and

(2) that the meatmeal consumption is higher in the 1937-38 trial; and

(3) that the bonemeal is higher in the 1937-38 trial.

The method of feeding has a marked impression on the respective consumption of the different foods. In the morning a wet mash is fed to all birds, irrespective of the breed, and a dry-mash hopper is open at all times in order to allow

the birds to have choice of extra food if required. The dry mash is mixed differently for each respective breed and it is here that the consumption has been found to be higher in 1937-38 than in 1936-37. This accounts for the smaller amount of wheat consumed in the latter year. The extra meatmeal consumed in 1937-38 has been due to the high fat content in some of the meal used. The fat content at times has been as high as 18 per cent. and this necessitated a higher percentage of meatmeal in the rations in order to obtain the correct balance.

The method of determining the meatmeal requirements in the ration has been to follow the colour of the droppings under the perches, together with the continual handling for condition.

The cost of feeding for the 48 weeks in 1937-38 was £127 1s. 5d., or equal to 10s. 3d. per bird, while the average return for eggs was 19s. 5¼d. The average profit therefore is 9s. 2¼d. per bird.

Note: Feeding costs are based on the retail prices of all goods as charged by metropolitan produce merchants whilst the returns for eggs are those received in open sales less 5 per cent. selling commission and a deduction of an account sales fee of 6d. per sales day (a sum equal to £2 12s. per annum).

AGRICULTURAL PROBLEMS.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

Albany	**H. R. Powell**
Bridgetown	**A. Flintoff.**
Bunbury	**M. Cullity.**
Geraldton	**N. Davenport (Government Buildings).**
Gosnells	**R. C. Owen.**
Harvey	**R. L. Cailes (Fruit); A. M. Tindale (Dairying).**
Katanning	**A. S. Wild.**
Kalamunda-Roleystone	**W. H. Read, c/o. Department of Agriculture, Perth.**
Kununoppin	**W. M. Nunn.**
Metropolitan, Gingin, Chittering ...	**S. E. Bennett, c/o. Department of Agriculture, Perth.**
Mundaring	**V. Cahill.**
Narrogin	**A. T. Gulvin.**
Vasse	**J. M. Nelson.**

HYDROPONICS.

The Growth of Crops in Water Without the Use of Soil.

L. J. H. TEAKLE.

Of recent years, particularly in the American press, there has been a considerable amount of attention given to the question of the commercial growing of crops in waters containing the ingredients necessary for plant growth. No soil whatever is used and immense crops have been reported.

As attractive references to this work have been made in publications available to Western Australian farmers (see a recent book by Bertrand Russell; "The West Australian Wheatgrower," of May 5th, 1938) and in view of certain inquiries from interested sources it is deemed appropriate that a statement be made on the subject.

The following information is derived from authoritative statements from the University of California Agricultural Experiment Station* and from other available reports.†

For three-quarters of a century scientists have been using water cultures as a means of ascertaining the requirements of plants. One of the foremost of the present-day investigators is Dr. W. F. Gericke, of the University of California, who has gone beyond the field of research and has proposed the method as a commercial means for crop production.

To Dr. Gericke is due the credit for the commencement of studies on a commercial scale and he and his collaborators have obtained sufficient data to show—

1. That hydroponics can succeed as a method of crop production.
2. The crop yield can be very high in terms of plant food used and area of ground required.
3. Special equipment and skilled attention is required for satisfactory results.
4. The skill of the gardener or farmer is just as necessary in the growth of crops in water culture as in soils and, in addition, a knowledge of the special technique peculiar to hydroponics is required.

A statement from the University of California discounts the importance of the reports of exceptionally high yields from water cultures and indicates that the yields from a fertile soil properly managed under glass-house conditions will be approximately the same as those from water cultures under the same conditions.

It is considered that "the method has certain possibilities in the growing of special high-priced crops, particularly out of season in glass-houses, in localities where good soil is not available, and where it is found too expensive to maintain

* "Statement concerning water culture method of crop production," September, 1937.

D. R. Hoagland and D. I. Arnon—"Growing plants without soil by the water-culture method," February, 1938. (Extracts from this paper have been freely used in the preparation of this note.)

† W. F. Gericke—"Hydroponics—crop production in liquid culture media," *Science* 85 : 177-178, 1937.

"Crops in Water," *Californian Monthly*, February, 1938, p. 11.

G. O. Brehm—"What about Hydroponics?" *California Monthly*, February, 1938, p. 12.

highly favourable soil conditions. Soil beds in glass-houses often become infected with disease-producing organisms, or toxic substances may accumulate. Installation of adequate equipment for sterilising soils and operation of the equipment may involve considerable expense." The use of water culture, expertly supervised, may enable the grower more readily to control the conditions for plant growth, to eliminate certain diseases and to economise, perhaps, on fertiliser ingredients.

The term "hydroponics" for the new art in agriculture was suggested by Professor W. A. Setchell, of the University of California, and is a variation of the Greek word "geoponics" meaning agriculture. As "hydro" means water the new term merely means water culture but implies the use of water culture for the growth of crops on a commercial scale.

As with plants grown in soil, those grown in water culture will require similar external conditions. It will be just as essential to have adequate light, heat, air, carbon dioxide and water under one condition as under the other. The talk of growing crop plants in water culture in dim basements and otherwise unsuitable places is absolute nonsense. In fact, Mr. George O. Brehm of Seattle, Washington, found that tomatoes could be grown successfully with hydroponics in the summer months but during the winter period in which the hours of daylight would range from 8½ to 9½ hours, tomatoes failed to grow normally and to set fruit.

Claims have been made that the plants produced by hydroponics are more valuable nutritionally than those from soils. It is well known that the nutritional value of plants is determined in part by the quality of the soil and by the fertiliser used but there is no evidence that water culture is superior to soils. In fact, it is known that the composition of the plant varies with the composition of the water culture as well as with the soil, and the nature and management of the water culture will be as important in the food quality of the produce as with soils.

GROWING OF PLANTS IN WATER CULTURES.

"The usual equipment for the commercial water-culture method consists essentially of long, narrow, and shallow tanks, which may be constructed of wood, cement, black iron coated with asphalt paint, or other sufficiently cheap materials which do not give off toxic substances. These tanks contain the nutrient solution in which roots of the plant are immersed. Wire screens are placed over the tops of the tanks, or inside, above the solution. The screens support a layer of bedding of varying thickness (often 3 or 4 inches), according to the kind of plant grown. The bed may be prepared from a number of inexpensive materials—for example, pine shavings, pine excelsior,* rice hulls. Some materials, such as redwood shavings or sawdust, may be toxic. Seeds are planted in the moist beds, or young plants from flats set in them with their roots in the nutrient solution. It is to be noted that roots may develop not only in the solutions in the tanks, but also in the beds. The shallowness of the tanks and the porous nature of the beds facilitates aeration of the root system—an essential factor—although it has not been demonstrated that such aeration unsupplemented by an additional oxygen supply would be optimal for all kinds of plants."

As far as possible the ordinary fertiliser salts may be used for the preparation of the solutions. Care should be taken to be sure that these salts contain no injurious substances (for example, fluorine is commonly found in phosphatic fertilisers) which, while harmless in the soil, may be toxic in a water culture.

The temperature of the solution should not be allowed to vary greatly and it seems likely that approximately 70 deg. F. will be satisfactory for many plants.

* Fine wood wool.

Artificial heating is resorted to in some of the Californian installations to maintain the appropriate solution temperature and it seems likely that some cooling arrangements may be necessary during summer heat waves.

THE NUTRIENT SOLUTION.

The water solutions for the growing of the plants are made from salts dissolved in almost any water which is fit for drinking purposes. Water which is even slightly brackish or saline must be avoided.

The following salts are then dissolved in the water preferably in the order mentioned:—

Salt.	Amount per 25 gallons of water.	
	Ounces.	Tablespoons.
mono ammonium phosphate	½	1 heaping.
potassium nitrate	3	6 level (powdered salt).
calcium nitrate	3	7 level.
Epsom salts (magnesium sulphate)	1¾	5 level.

An alternative solution may be prepared as follows:

Salt.	Amount per 25 gallons of water.	
	Ounces.	Tablespoons.
potassium phosphate (monobasic)	½	1 level.
potassium nitrate	2½	5 level (powdered salt).
calcium nitrate	3½	8 level.
Epsom salts (magnesium sulphate)	1¾	5 level.

To these solutions certain "minor" elements must be added in small amounts.

1. *Iron Solution.*

"Dissolve a level teaspoon of iron tartrate (iron citrate or iron sulphate can be substituted, but the tartrate or citrate are often more effective than the sulphate) in a quart of water. Add half a cupful of this solution to 25 gallons of nutrient solution each time iron is needed (once weekly, or more frequently if the plants are pale)."

2. *Boron Solution.*

"Dissolve a level teaspoon of powdered boric acid in a gallon of water. Use a pint and a half of this solution for each 25 gallons of nutrient solution."

3. *Manganese Solution.*

"Dissolve a teaspoon of crystalline, chemically pure manganese chloride ($MnCl_2 . 4H_2O$) in a gallon of water. Manganese sulphate can also be used. Dilute one part of this solution with 2 parts of water, by volume. Use a pint of the *diluted* solution for each 25 gallons of water."

4. *Zinc Solution.*

"Dissolve a level teaspoon of crystalline, chemically pure zinc sulphate ($Zn\ SO_4 . 7H_2O$) in a gallon of water. Use 4 teaspoons of this solution for each 25 gallons of nutrient solution."

5. *Copper Solution.*

"Dissolve a teaspoon of chemically pure copper sulphate ($CuSO_4 . 5H_2O$) in a gallon of water. Dilute one part of this solution with 4 parts of water; use one *teaspoon* of the *diluted* solution for each 25 gallons of nutrient solution."

Furthermore, the growth of the plant causes the solution to become alkaline and it must be adjusted to the more favourable slightly acid condition (pH6).

This is done by means of 3 per cent. sulphuric acid as follows:—

> Take exactly one quart of the solution in a white porcelain dipper and add sufficient brom,thymol blue indicator* to give a visible colour. A yellow colour indicates slight acidity when no adjustment is necessary. Green is indicative of a neutral reaction and blue an alkaline reaction. If the indicator gives a green or blue colour add the 3 per cent. sulphuric acid from a burette to the quart of solution until it *just* turns yellow. Carefully note the amount taken by reading the burette and then add just one hundred times as much of the acid to the 25 gallons of solution to effect the same adjustment. If the volume is not 25 gallons a proportionate amount should be used.

This test with the indicator should be made every day or so during the growth of the plants and adjustment made with the acid when necessary.

TANKS AND OTHER CONTAINERS FOR NUTRIENT SOLUTIONS.

"Various kinds of tanks and containers have been utilised for growing plants in water culture. Tanks of black iron, well painted with asphalt paint (most ordinary paints cannot be used, because of toxic substances), have proved satisfactory for experimental work. Galvanised iron may give trouble, even when coated with asphalt paint, if the paint scales off.

"Concrete tanks have been tried, but they may require thorough leaching before use. Painting the inside of the tank with asphalt paint is advisable. Wooden tanks will serve the purpose, if made watertight.

"The dimensions of tanks must be selected in accordance with the objective. One kind of tank, of large size, adapted to many purposes, has dimensions of 10 feet in length, 2½ feet in width, and 8 inches in depth. A smaller tank, 30 inches long, 12 inches wide, and 8 inches deep, is convenient for use in many experiments. In general, shallow tanks will be found suitable. The length and width may be determined by consideration of convenience.

"A heavy chicken-wire netting (1-inch mesh), coated with asphalt paint, is fastened to a frame and placed directly over the tank to provide support for the porous bed. In constructing a frame, it is desirable to leave several narrow sections not covered with wire netting, but with wooden covers which can be conveniently removed for inspection of roots, or for adding water or chemicals. The wire netting should be stretched immediately above the surface of the solution, when the tank is full. Cross supports may be placed under the netting to prevent it from sagging.

"A carpenter or mechanic can design and build suitable tanks and frames, which may take many forms, and further detailed description is unnecessary for the purpose of this circular."

* Obtained from the wholesale drug stores in Perth.

NATURE OF BED.*

"The wire screen is covered by a layer of porous bedding material several inches thick—thicker when tubers or fleshy roots develop in the bed. Various cheap bedding materials have been suggested: pine excelsior (fine wood wool), peat moss, pine shavings or sawdust, rice hulls, etc. Some materials are toxic to plants. Redwood should usually be avoided. One type of bed which has produced no toxic effects in experiments carried on in Berkeley, with tomatoes, consists of a layer of pine excelsior, 2 or 3 inches thick, with a superimposed layer of rice hulls about 1 or 2 inches thick. For plants producing tubers or fleshy roots, some finer material may need to be mixed with the excelsior. This is also essential when small seeds are planted in the bed, to prevent the seeds from falling into the solution and to effect good contact of moist material with the seed. In all cases, the bed must be porous and not exclude free access of air.

"If seeds are planted in the bed, it must, of course, be moistened at the start and maintained moist until roots grow into the solution below. The bed should also be maintained in a moist state, by occasional sprinkling, for the development of tubers, bulbs, fleshy roots, etc. *Great care should be observed to prevent waterlogging of the bed, which leads to exclusion of air and to undesirable bacterial decompositions.*"

PLANTING PROCEDURES.

"Seeds may be planted in the moist bed, but often it is better to set out young plants chosen for their vigour, which have been grown from seeds in flats of good loam. In transplanting from a flat of soil, the soil is thoroughly soaked with water so that the plants can be removed with the least possible injury to the roots. The roots are then rinsed free of soil with a light stream of water and immediately set out in the beds, with the roots immersed in the solution. If young plants are set out, the roots are placed in the solution, and at the same time the layer of excelsior is built up over the screen. Then the layer of rice hulls is placed on top of the excelsior. If seeds are to be planted in the bed, the whole bed must be installed and moistened before the seed is planted."

SPACING OF PLANTS.

"In the experiment with tomato, plants were set close together, in some instances 20 plants to 25 square feet of solution surface. No general advice can be offered as to the best spacing. This depends on the kind of plant and on light conditions. Individual experience must guide the grower."

ADDITION OF WATER TO TANKS.

"In starting the culture, the tank is filled with solution almost to the level of the lower part of the bed. As the plants grow, water will be absorbed by plants or evaporated from the surface of the solution, and the level of the solution in the tank will fall. The recommendation has generally been made that after the root system is well developed, the level of the solution should remain from one to several inches below the lower part of the bed, to facilitate aeration. However, since the solution level should not be permitted to fall very far, regular additions of water are required."

* The general arrangement of this type of bed was first described by W. F. Gericke and J. R. Tavernetti. *Agricultural Engineering*, 17 : 141-43, 1936.

CHANGES OF NUTRIENT SOLUTION.

"As the plants begin to grow, nutrient salts will be absorbed and the acidity of the solution will change. More salts and acid may be added, but to know how much, chemical tests on the solution are required. When these cannot be made, an arbitrary procedure may be adopted of draining out the old solution every week or two, immediately refilling the tank with water, and adding salts and acid, as at the beginning of the culture. The number of changes of solution required will depend on size of plants, how fast they are growing, and on volume of solution. Distribute the salts and acid to different parts of the tank. In order to effect proper mixing, it may be well to fill the tank at first only partly full (but keep most of the roots immersed) and then after adding the salts and acid, to complete the filling to the proper level with a rapid stream of water."

Another method of maintaining the supply of fertilising ingredients is to make up a strong solution of the substances listed above and to add a little of this each week or as the plants show signs of under-nutrition. If the quantities listed above are dissolved in one gallon instead of 25 it will form a strong stock solution. A cupful of this solution mixed with the culture solution every week when the plants are growing vigorously or whenever the plants show signs of losing their natural green colour should suffice.

CROWN PACK FOR APPLES AND PEARS.

Report made by Mr. A. FLINTOFF, Horticultural Instructor, upon his return from Tasmania.

In reporting on my visit to Tasmania in connection with the "Crown" method of packing apples and pears, I have to state that I spent a fortnight in that State during which time I was accorded the best of treatment from Mr. P. H. Thomas and his officers. No effort was spared in order to show me most that would be of interest regarding the special mission that was the purpose of my visit.

The South, Central and Northern centres were visited and many fruit packing establishments gave us the opportunity of examining the various methods of putting up apples and pears for export. I was also given bench room in order to put into practice the principles of "Crown" packing which had already been explained at Hobart Headquarters.

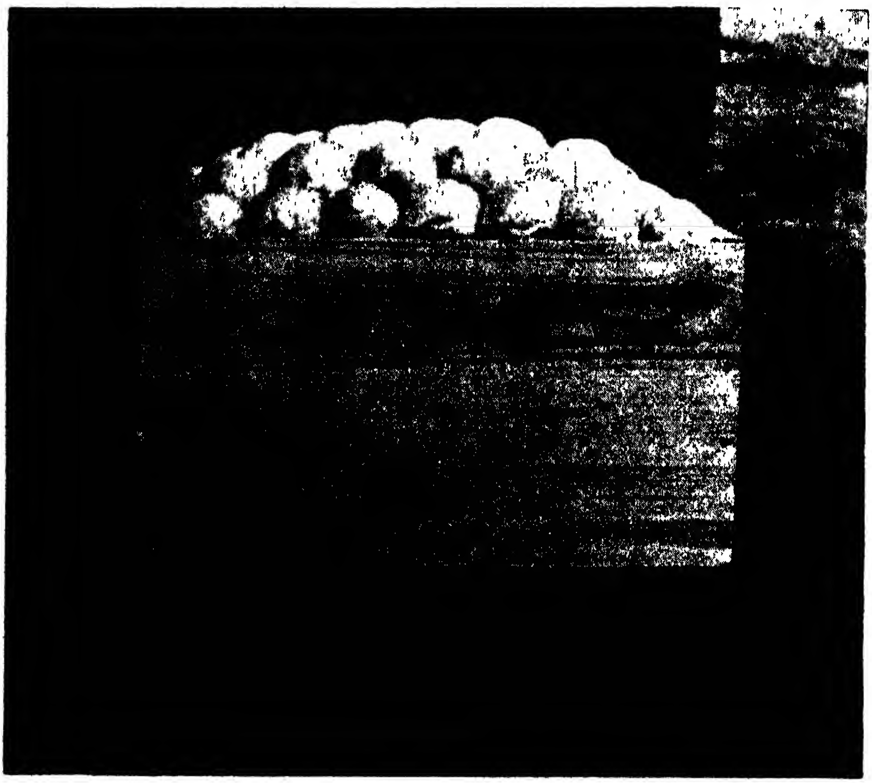
I may state that Mr. M. Large is the packing instructor in the south and Mr. K. Pearce in the north. I found both these officers very desirous of making my stay pleasant as well as instructive.

In regard to the boxes used for apple and pear packing, I note that various types are in commission—all hard woods (native) which are light coloured and, if well cut are quite presentable; a box which the Tasmanians term a "Shandy" case, ends and sides hard woods, tops and bottoms imported pine; and a wholly softwood case (imported pine). Of the three types, the all softwood case is most favoured by keen growers and also by Government officials, these cases being clean, well cut and attractive.

The "Shandy" case, because of being a little cheaper, is favoured in some quarters and, if well cut and clean the difference in colour between tops and bottoms, and the body of the case is not very pronounced as the Tasmanian hard woods are light in colour.

The all hard wood is a shade cheaper again, but is not favoured to date by packers using the "Crown" pack as the tops and bottoms are not sufficiently flexible, and appear to put undue pressure on the fruit when the case is being nailed down.

At Hobart I inspected packed cases of all types, and certainly the imported wood showed to advantage. Regarding hardwood tops and bottoms, I examined some at Mr. Cottier's sheds in Hobart. These are peeled wood. I understand the logs are softened and then "peeled" from the round. There seems some promise in this method of obtaining thin boards from hard woods. The fibre is weakened across the board, but longitudinal grain appears unimpaired. This weakening of



Standard bushel case. Crown pack. Side view.

the fibre prevents any "curl" of the boards and, in actual practice, the boards under the nailing down press seem to fold over the fruit satisfactorily. In the event of Western Australia ultimately using the standard case, this method of cutting tops and bottoms from hard woods may be worth consideration. A saving of 25 per cent. in timber as against the sawn cut boards is claimed.

Tasmanian growers have practically discontinued the use of the Australian bushel case for export other than when sending to mainland States.

In reference to the "Crown" method of packing apples and pears, not all packers have made the change over from the usual high straight or flat pack. Naturally, growers look upon the innovation as upsetting the established routine of the shed work.

Standard bushel case. Crown pack. Side view with side removed.

Mr. Thomas, however, is making every effort to bring about its universal adoption. To packers who understand the principles governing the packing of apples and pears, the change over represents no difficulty and a few days' practice with the different sizes in fruits will suffice to familiarise the packer with the whole operation.

Of course, there are certain sizes of fruit that require care in arrangement in order to bring the final layer to the correct height, but this refers to any fruit case in use. The packing of apples and pears in the Standard case is simple in comparison with the system used with the Australian Bushel, there being no diagonal packs. The box (Standard) being 10½ inches deep as against the Australian bushel depth of 14¼ inches also simplifies the operation. The "pack" used previously (and still used in many sheds) is what may be termed the high flat pack, the bulge being forced into the lid by the high fruit at each end of the case.

In the "Crown" pack, the principle lies in "building" the bulge into the *fruit* so that the lid, being flexible, "lays" over the fruit and with a well-packed case, no great pressure is needed when nailing down.

The actual packing of the fruit as advised and taught by Mr. Thomas is as follows:—

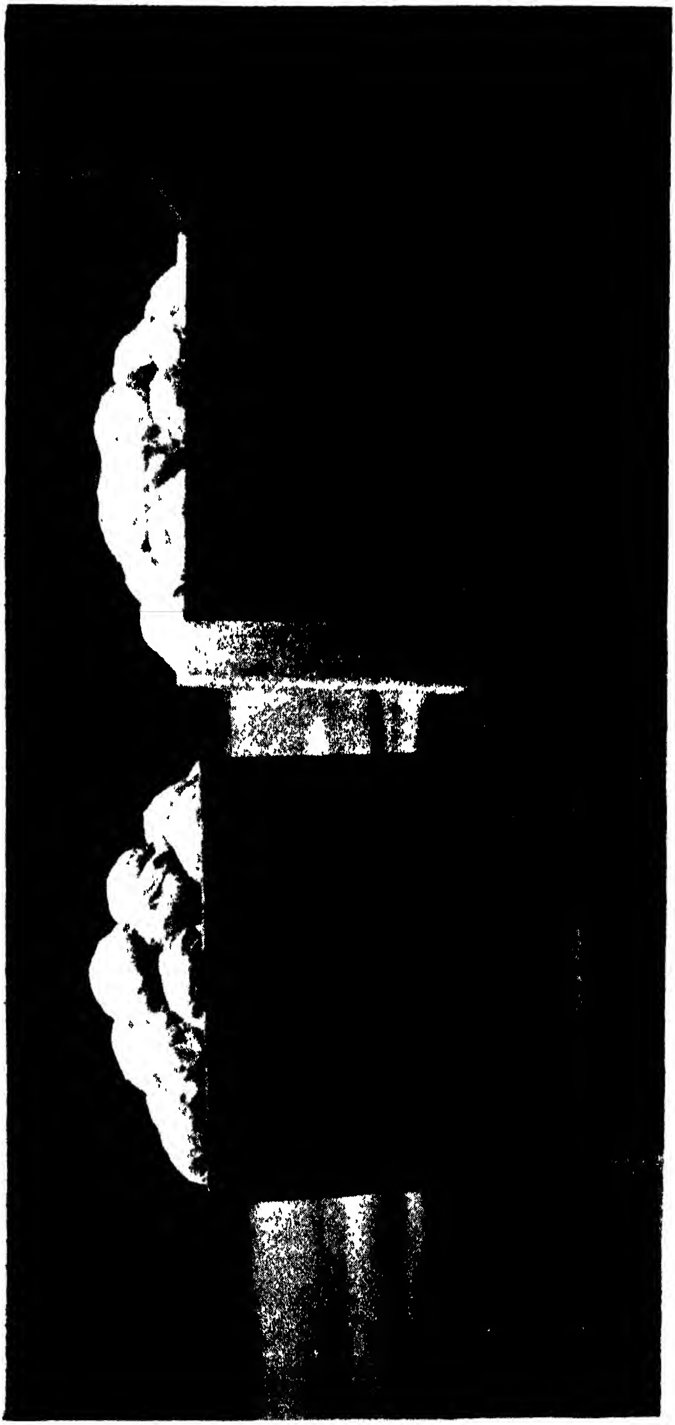
The first layer is packed as per chart leaving out the last "set" of fruit. The second layer is then proceeded with until the end of the first layer is reached. At this stage both hands are used to pull back the first or bottom layer. This action has the effect of partly "bunching" up the fruit midway in the case. The finishing fruits are then placed in the bottom layer and the pack proceeded with. In each layer, including the second, the fruit is placed in the "pockets" provided by the previous layer in the usual sequence, but as the fruit is placed in the pockets at the sides and ends of the case a firm downward pressure is exerted, the central fruits being simply laid on the "pad" formed by the paper. No appreciable extra time is absorbed in this firm pressure action. As each layer is added in the same way, the crown is being built so that, with the finishing layer, the "Crown" is such that the fruit appears to dome from sides and ends. The difference in fruit weight, high flat pack v. Crown, is not great, but the disposition of fruit in the "Crown" keeps the side and end fruit comparatively low.

In every instance the calyx of the fruit faces the end of case, *i.e.*, the commencing and finishing fruit of each layer is turned so that the calyx faces the wood, also the fruit is so placed as to show what is termed a four-side inspection. The first layer is wrapped in such a way as finally to go into the case with the finishing paper "tails" upwards. All fruits are placed then so that should the case be opened either top, bottom or sides, no paper tails are showing.

The finish of the "wrap" shows a half twist on the paper.

I have attempted to detail the operations as advocated by Government officials. Some deflections from this ideal are sure to be made and I certainly found this to be the case. When in the north of the State I spent several days with the Government Packing Instructor, Mr. K. Pearce, who followed two seasons in the States of America. Mr. Pearce does not follow in detail the ideal above mentioned. No doubt he finds that growers are a little antagonistic regarding the exactness of the above-mentioned operation.

I understand that the twist of the paper is not generally followed in America, and in fact, Mr. Pearce does not use it. Furthermore, the turning up of paper tails in the first layer is not generally practised. Nor is the temporary non-completion of the first layer considered of prime importance. In eliminating these "extra" movements it is claimed that time and annoyance are saved.



Standard bushel case. Crown pack. End view.

The following method, as practised by many reputable growers, appeared to me commercially sound. The photographs enlarged were taken from results of this pack:—

First layer is *completed*, fruit placed with "pad" of paper *down*. Calyx of fruit facing case at each end.

Second and succeeding layers continued in the order as before explained, firm downward pressure on outer fruit, central fruit resting more or less lightly on paper "pads."

No half-twist when completing the wrap. Although the underhand wrap, as practised by Mr. Pearce, is very satisfactory, many packers rather "slum" the finish of this wrap, sacrificing neatness for a little extra speed. Paper tails must be turned in on sides of cases as sides are practically the only places opened for inspection, that is, with the "standard" case.

I consider that the "Crown" method of packing apples and pears is superior to the usual flat high packs used previously, the main reason being that the same weight of fruit (perhaps a little more) is more easily built into the case and presents a better proposition for lidding, as the fruit is lower at ends and sides, the general pack having more "spring." It is claimed that to get the previous high flat packs different sizes in fruits were used, that is smaller fruits at each end. This appears to have been the general practice.

With the "Crown" pack such is not entirely the case, at the same time a good packer will often place rather smaller fruit at the ends. This has been practised also with the Australian bushel case.

COMPARATIVE FRUIT WEIGHTS.

From time to time statements have been made regarding the difference in weights (Standard v. Australian bushel) of fruit in a packed case, some, to the effect that there is a difference of 4 to 5 lbs. in favour of the standard case. That is to say, taking medium sized $2\frac{1}{2}$-inch apples at 4 to the pound, there would be at least 16 apples more in a standard. This may have been so some years ago when the Australian bushel case was undersized and weight parity round about 38 lbs. net for Jonathans.

Since returning to Bridgetown, I have gone into this matter in accordance with your instructions with both pears and apples. With Jonathans, our lightest export apple, 42 lbs. av. nett weight can be packed into a correctly sized case. With the "Standard" case the average nett weight is approximately 44 lbs.

Tasmanian chart gives this average for Jonathans. I was careful to use the same apples when testing these weights packing the same fruit from one type of case to the other.

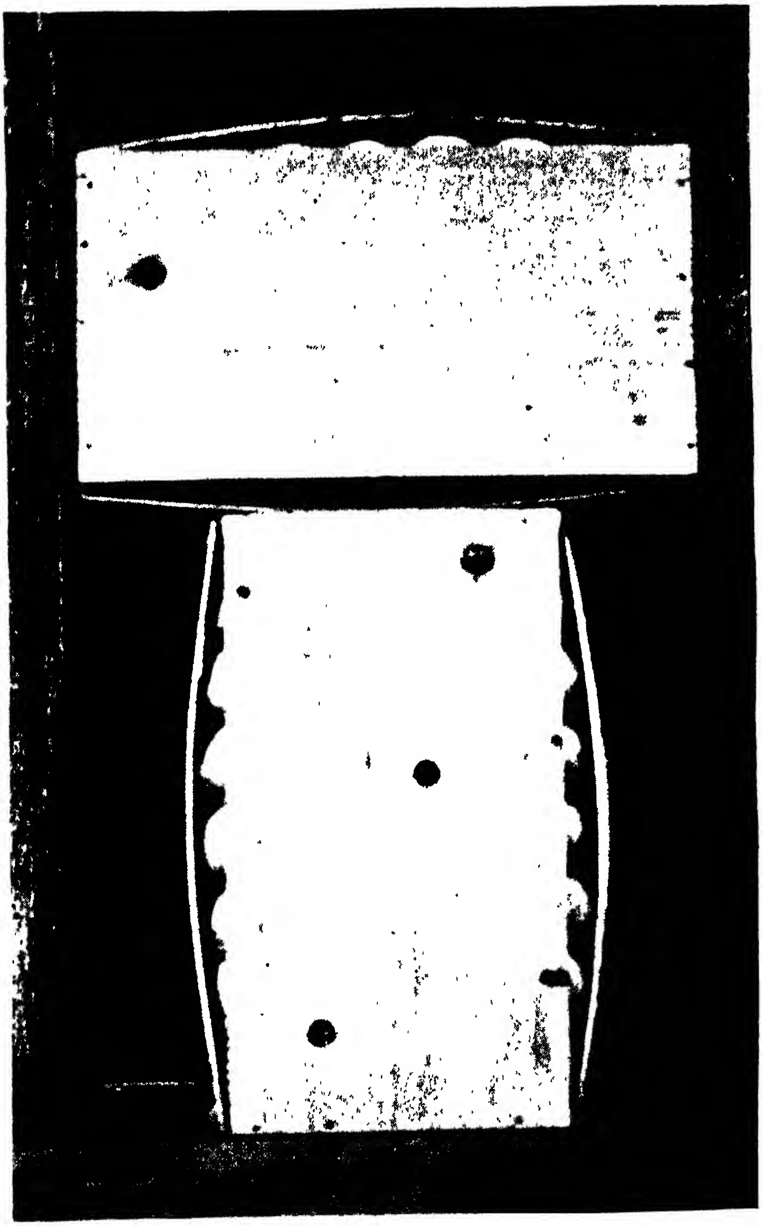
As a general rule the chart numbers vary to the extent of 5 to 8 apples. *i.e.*,

Australian	Bushel	175	count	is	"Standard"	180
"	"	144	"	"	"	150
"	"	193	"	"	"	198
"	"	132	"	"	"	138
"	"	120	"	"	"	125
"	"	108	"	"	"	113

It is obvious that round about $1\frac{1}{2}$ lbs. to 2 lbs. more weight is in favour of the standard case.

There is a little difficulty in comparison of counts as Tasmanian fruit is largely packed to count. Thus a case packed to count and not to size may contain

say 50 per cent. of large 2½-inch and 50 per cent. small 2¾ with possibly no more than ⅛-inch variation in size of fruits within the case. Under the regulation branding to size would rule this pack out. Yet in certain packs, say our very large



Standard bushel case. Crown pack. Cases nailed down.

2½ Granny Smith 140 apples 5 x 5 — 2 x 2 straight pack it is almost essential, if one would put the correct weight of fruit (44 lbs. nett) to use some apples just over the large 2½-inch.

I have to hand enlargements of photos of packed apples. The fact that the cases are lying quite flat rather accentuates the bulge and in that respect is slightly misleading as, even if the case was on the ordinary packing stand the side apples would show about ¾-inch lower. Otherwise, I consider the illustration will serve a purpose.

"CROWN" PACK IN AUSTRALIAN BUSHEL.

Having tested out the "Crown" method of packing our bushel case, I am convinced that a modification of the system can be used with advantage. Obviously the comparative narrowness of the dump does not lend itself to building up from the sides, but end to end the measurement is the same.

I have tried the system in several ways and am fairly confident that the end fruits can be kept down and so eliminate that objectionable feature of high end apples as seen so frequently in our general packs.

Regarding pear packs, I have tried out several sizes in Winter Nelis only and find it easy to get 45 lbs. nett in the standard pear case.

THE MOVEMENT OF SOLUBLE SALTS IN SOILS UNDER LIGHT RAINFALL CONDITIONS.

By L. J. H. TEAKLE and G. H. BURVILL.

It is universally recognised that soluble salts are liable to accumulate in soils where the rainfall is light, that is, where it is insufficient in amount to cause a movement of water *through* the soil into the drainage system. These conditions are generally indicated by the occurrence of a very slightly soluble salt, calcium carbonate, in the subsoil and, in the agricultural areas of Western Australia, occur where the annual rainfall averages less than about 15 inches. Associated with the calcium carbonate will be found certain soluble salts and, of these, in Western Australia sodium chloride is by far the most important Sodium chloride constitutes from 10 or 20 per cent. of the total water soluble salts where the concentration is low, to about 80 per cent. where the concentration is high. Generally for soils in which the concentration of water soluble salts is above 0.50 per cent., the proportion of sodium chloride is of the order of magnitude of 60 to 70 per cent.; in fact, the proportion is similar to that in sea salts.

By way of definition it may be stated that *low* rainfall areas are those having a *low* average annual precipitation—say less than 15 inches in Western Australia. The *light* rainfall portion of the State receives less than 20 points of rain per wet day and stretches from the eastern wheat belt eastwards into South Australia.

A question of vital importance in some districts in Western Australia is the movement of water soluble salts in the soil following the clearing of the timber. The answer to this question is afforded by the results of five years' experience in the course of soil surveys in the wheat belt under rainfall conditions ranging from 11 to 16 inches per annum. As chlorides are the principal constituents of the water soluble salts fraction and as chloride moves somewhat more readily in the soil than other ions, a study of the movements of chlorides is taken as a basis for the conclusions arrived at. In most of the work, the chlorides were determined by Best's (1929) method while the conductimetric procedure described by Samuel and Teakle (1931) was used to give a measure of the total water soluble salts. A number of check samples were examined by the usual gravimetric procedure.

As any movement of water soluble salts will be conditioned largely by moisture movements some review of the current viewpoint concerning water movements in soils must be attempted.

Moisture Movement in Soils.

The phenomenon of capillarity, and the possibility of the movement upwards of moisture and, with it, other materials by capillarity, have long interested soil investigators. The action of the sun, in evaporating moisture at the surface, was presumed to supply the energy for drawing moisture from extraordinarily great depths by virtue of the phenomenon of capillarity. On theoretical grounds Mitscherlich (1901), in Germany, calculated that the maximum possible capillary rise in heavy clays and loams would be of the order of magnitude of two miles. Sir Daniel Hall (1912, p. 99) supported the idea but considered that movement may be expected from a depth of 200 feet. Cameron, in America, held similar views and also imagined the waters rising by capillarity to bring up important supplies of phosphate and potash. Keen (1919) estimated that in an "ideal" clay, capillarity would be effective over a theoretical maximum height of 150 feet. Similar considerations are the basis of an explanation of the formation of "laterite" offered by some geologists.

It is very fortunate that field and experimental evidence does not support these theories, as, otherwise, where leaching is not very effective and where long dry spells occur, the surface of the soil would be a "crust" of salts and quite unsuitable for the growth of the present types of plants. When columns of dry soil are stood in water, capillary rise occurs, but the rise is generally of the order of magnitude of two to three feet. The more powdery and silty soils are most active and may raise water to a height of four or five feet while the maximum capillary rise recorded seems to be for a finely ground rock flour, with particles of .005 mm to .016 mm diameter, for which Loughridge obtained a height of 122 inches in 18 months (see Hilgard, (1912, p. 203)).

Alway and McDole (1917) review the situation and find that in actual practice capillary action in soil is generally of small importance. Plant roots go for water and nutrients as these do not move towards the roots by capillarity to a sufficient degree to supply requirements. They cite Canadian experience which indicates little or no loss of water from the soil by evaporation at depth greater than one foot. Also, Rotmistrov made an exhaustive field study near Odessa* under conditions where the permanent water table was over 100 feet from the surface. It was observed that the subsoil was permanently moist below the zone of root action but no water percolating below a depth of 16 to 20 inches ever returned to the surface except via the roots. Below this depth, water not absorbed by the roots goes down, apparently in annual waves, at the rate of about 7 feet per annum at Odessa. Alway and McDole also cite the conclusion of Leather at Pusa, India, that the maximum distance from which water moved upwards was 7 feet.

Vaidhianathan and Luthra (1934) consider that the upward movement may be felt as deep as 22 feet in the Punjab Irrigation area.

This view is supported by further evidence from the 1936 annual report of the Punjab Irrigation Research Institute cited in Monthly Letter No. 69 of the Imperial Bureau of Soil Science. In the work of the Institute "it has been shown that soil deterioration due to salinity may take place when the water table reaches

* Odessa has an average annual rainfall of about 17 inches (425 mm.) based on 30 years' records 1866 to 1895. The precipitation is fairly evenly distributed by months as the monthly averages range from about 1 inch to 2 inches. The maximum monthly recordings are for June and July.

a depth of 18 feet from the surface, if the groundwater or soil profile contains sodium salts." These figures are in excess of those generally accepted by modern opinion and it is suggested that the climatic conditions of the Punjab are an important factor in the divergence.

A valuable contribution to the problem has been made by Wadsworth (1931) who shows that capillary movement upwards is active only at *field capacity*† or higher moisture figures. Other investigators have shown that movement from a moist soil—below field capacity in moisture content—to an air dried soil is practically non-existent beyond raising the dry material to the hygroscopic coefficient or the moisture content in equilibrium with a saturated atmosphere.

An interesting series of experiments by Shaw and Smith (1927) provide important data for sandy loam and loam soils in California. Columns of soil at field capacity were stood in water at depths ranging from 4 to 10 feet and a current of warm air gently blown across the surface of the soils. The loss of water from the reservoirs was measured and shows that loss is rapid where the water table is within 4 feet of the surface. A slow loss is obtained where the column of soil is 6 feet above the free water level and a significant loss was measured in the loam soil from a depth of 8 feet. Practically no loss was observed when the water table was at 10 feet.

In heavy clay soils Childs (1936 a and b) and Nicholson and Childs (1936) show that the laws of diffusion and not those of capillarity fit the experimental data for moisture movement.

Veihmeyer (1927) has shown that moisture movement in soils is very slow when the moisture content falls below the field capacity. At higher moisture contents the soil moisture in the subsoil below 16 to 20 inches will always move downwards, unless absorbed by plant roots, and will carry with it the water soluble salts. Thus the danger of a general rise of salt from the subsoil, except where a shallow water exists or where special soil conditions occur, is non-existent.

From all of this evidence it seems that the following practical conclusions regarding moisture movement in soils may be reached:—

(1) Capillary is not effective except over short distances in the soil mass and plant roots grow to the supplies rather than being fed by capillarity.

(2) Capillarity is active in soils only at moisture contents at or above field capacity.

(3) The extent of capillary movement of water upwards from a free water surface depends on the soil type and ranges from a few inches in sands to four or six feet in ordinary soils and five to 10 feet in certain silty soils and materials such as finely ground rock flour.

(4) Under field conditions where no water table exists, loss of water by surface evaporation will be generally confined to the surface 12 to 20 inches. It is considered that further loss will be due to the escape of water vapour from within the soil mass. Where an impervious subsoil causes the surface layers to become waterlogged or maintained at or above field capacity for any length of time, capillarity becomes a factor in the loss of water from greater depths by surface evaporation.

† Field capacity may be defined as the amount of water held in the soil under field conditions as soon after an irrigation or heavy rain as the excess moisture has been removed by drainage.

(5) Both capillarity and diffusion will be factors in moisture movement in soils over short distances.

(6) Under the influence of gravity the predominant tendency will be for movement of moisture to be downwards.

The data which are now to be presented on the movement of soluble salts in soils under light rainfall conditions may be conveniently grouped under three headings:—

A. Surface accumulations of soluble salts.

B. The effect of clearing the natural vegetation on the movement of soluble salts in the soil under an 11- to 16-inch rainfall.

C. The movement of salts in fallowed soils in tanks at the Merredin Research Station.

A.—SURFACE ACCUMULATIONS OF SOLUBLE SALTS IN SOILS.

Conditions under which surface accumulations of soluble salts are liable to occur in soils must be recognised for a proper appreciation of the incidence of soil salinity. Of course, where the rainfall is adequate, the general movement of salt is *downwards* into the drainage system. Thus Weller (1926) found that the amount of salt annually entering the Mundaring reservoir, near Perth, where the average rainfall is about 40 inches, approximates that deposited each year on the catchment by the rainfall. With lower, and more especially with light rainfall conditions, a much smaller proportion of the rainfall finds its way through the soil into the drainage system. If circumstances arise which allow its return to and evaporation from the surface of the soil, then surface accumulation of soluble salts occurs and may become an important agricultural problem.

Light rainfall areas will generally be most liable to salt problems. In the light rainfall areas of Western Australia surface accumulation of soluble salts is observed to occur under at least five conditions—

1. Where a high water table exists;
2. From evaporation of seepage water;
3. On the rims of crabholes; where the micro-relief and texture favour surface evaporation;
4. Where special soil characters lead to the establishment of capillary connection between a saline subsoil and the surface in the absence of a shallow water table;
5. Surface concentration on areas with saline subsoils but without unusual micro-relief or structure.

1. *The Danger of a High Water Table.*

The most serious surface accumulations of salts in soils in agricultural practice are most generally associated with irrigation projects in which excess of water is used without adequate provision for drainage, and the water table rises.

In the United States of America a million acres of valuable irrigation land has been virtually ruined by the surface accumulation of soluble salts resulting from the excessive application of irrigation water which led to a rise in the water table. At Billings, Montana, the water table, prior to the introduction of irrigation, ranged from 20 to 50 feet deep, but within 12 to 15 years from the commencement of watering had been raised from 3 to 10 feet of the surface. In many instances test wells showed water containing 0.3 to 0.5 per cent. water soluble salts at less than five feet from the surface and low-lying areas had become bogs and salt swamps. At Fresno, California, where the water table had originally stood at about 30 feet deep, excessive irrigation resulted in a fluctuating water

table standing at two to three feet below the surface during the summer months. Similar conditions have developed in Utah irrigation areas. Surface accumulation of water soluble salts has caused severe damage to crops in each of these instances.

Review of the situation in the United States of America generally shows that two factors are of paramount importance in the vertical distribution of salts in soils—

(a) the character of the soil;

(b) the depth of the water table.

Sandy soils, with low capillary powers, could be managed and maintained free of salt in the surface with a water table not less than three feet from the surface. A depth of four feet is recognised as more desirable. With other soil types greater depths are necessary, as serious surface accumulations are generally observed where the water table is as shallow as four or five feet in midsummer. Little trouble is ever experienced with the water table at 10 feet or lower.

Conclusive supporting evidence is available from many sources. Thorp (1936, p. 178), describing saline delta soils in China, finds that where the brackish subsoil water is deeper than five or six feet during the dry season, the upper soils contain little salt and good crops of wheat, barley, cotton, etc., may be grown. However, where the water table, either permanent or perched, is less than 4½ to 5 feet during the dry season, surface encrustation of salt occurs as a result of capillary movement.

In the Western Australian wheat belt, under a rainfall of 11 to 15 inches per annum, low-lying country carrying certain teatrees and characteristic eucalypts in the virgin state, and having the appearance of filled-in lake or river channels, have become affected with salt in the course of 10 to 20 years of development. This is associated with the rise of the salt water table due to seepage into these low-lying areas. (See Table 1.) Instances observed on farms at Moulyinning, Wagin, Carnamah and Broomehill may be mentioned to show that where the saline subsoil water has risen to less than 5 or 6 feet of the surface in such valleys and flats, surface accumulation of salt is very likely to occur.

The results of observations in the Lake Brown district in Western Australia are thought to lend general support to these conclusions as surface salt accumulations, in the form of bare patches, in relatively heavy textured soils are liable to occur where the salt water table is as deep as 10 to 11 feet below the surface.

It seems that the best that can be done under these circumstances is the fostering of pasture plants such as wimmera rye grass, barley grass, salt bushes, etc., which may take possession of portions of the areas. Certain cheap drainage works may be advisable in some cases but will generally be too expensive to undertake.

2. *Evaporation of Seepage Water.*

In Western Australia, a common cause of salt accumulation is seepage of water which results from the clearing of large tracts of country in the course of development. When the country was virgin the vegetation largely controlled the movement of soil moisture but when this was removed percolation increased, springs developed and creeks, previously dry for most of the season, became more or less permanent sources of water. This seepage and subsoil water varies from quite good domestic quality (about 50 to 100 grains of total water soluble salts per gallon) to brackish (say 700 grains per gallon) and highly saline (3,500 grains per gallon). (See Table 1.) With long continued periods of evaporation, even with good or brackish water sufficient quantities of salts are brought to the surface to produce saline soils. These saline patches occur on slopes and on the banks of creeks throughout the agricultural areas but, in most cases, do not extend to more

than a few acres on any one farm. In a recent investigation at Broomehill it was observed that these patches developed where the brackish seepage water or "stream" came within less than about four feet of the surface. They are very obvious and undesirable, nevertheless, and should be prevented as far as possible by proper control of seepage water. Establishment of water-absorbing pasture and forage plants, in some instances supplemented by drainage, should, in most cases, effect control.

TABLE 1.

Salt Content of Subsoil Water, Water of Springs, Salt Dams, Shallow Wells and Bores in the Agricultural Areas.*

Serial No.	District.	Depth. (feet).	Salt.	
			Per cent.	Grains per Gallon.
1	Moulyinning	5	3·22	2,250
2	do.	3	2·83	1,980
3	do.	2½	1·09	763
4	do.	soak	0·34	238
7	Boodarockin	14	5·01	3,510
8	Campion	11	5·27	3,690
13	Wyalkatchem	3	1·52	1,060
32	Hindmarsh	19 (bore)	2·66	1,860
33	do.	30 (bore)	0·78	546
53	do.	11 (bore)	0·12	84
54	do.	9 (bore)	0·52	364
79	Cleary	8 (soak)	1·12	784
80	do.	12	5·07	3,550
81	do.	11	4·72	3,300
83	do.	5 (in clay pan)	3·25	2,280
82	Beacon Rock	35 (bore)	3·19	2,230
12	Corrigin	3	2·15	1,500
89	Moora	Pool in creek (December)	1·00	700
90	do.	Same pool (February)	1·72	1,204
21	Wagin	Dam	1·67	1,170
22	do.	Dam	1·30	910
23	do.	Soak	0·113	79
24	do.	5	0·087	61
25	do.	Spring	1·55	1,080
27	do.	Well	1·14	798
28	do.	Spring (adjacent 27)	1·12	784
29	do.	20 (well)	2·42	1,690
30	do.	3½	3·47	2,430
52	Katanning	Dam	1·92	1,340
9	Salmon Gums	6	5·92	4,140
10	Grass Patch	12	3·85	2,700
11	Kumarl	20 (well)	0·425	298
84	Bridgetown	Soak in creek	0·25	175
86	do.	10 (well)	0·47	330

* Salt expressed as NaCl calculated from total chloride.

NOTE.—Sea water contains 3·13 per cent. salt as NaCl calculated from total chloride.

3. *Evaporation from the Rims of Crabholes.*

In the drier parts of the wheat belt are areas of heavy soils which show an uneven surface, with many depressions known as crabholes or gilgais. These crabholes vary from 10 to 30 feet across, and from 2 to 6 feet deep, and in the winter are frequently filled with water for considerable periods.

Some discussion of their nature has been given by Prescott (1931, p. 15) who uses the results of H. N. England's work. It seems likely that the crabholes commence as cracks in the heavy clay soils and, as suggested by England, gradually form a depression surrounded by a rim somewhat above the normal level of the soil. As this rim is raised, probably as a result of clay expansion on moistening, erosive forces remove the surface and the soil of the rim exhibits subsoil characters. In the opinion of the writers the process goes further than this. During the period that standing water occurs in the depression, the soil under the rim becomes saturated and water evaporates from portions of the surface of the rim. Thus, the normal direction of the soil forming process is reversed and, instead of moisture and dissolved matters moving downwards, there is upward movement and the surface deposition of subsoil characteristics such as calcium carbonate, water soluble salts, etc., in these portions of the rim. In some instances the concentration of soluble salts on these rims becomes excessive and leads to the formation of bare, crusty or powdery patches known as crabhole puffs. This explanation is offered for the common occurrence in some districts of saline patches on the rims of crabholes in heavy country. Salt patches also occur on the level shelf areas between the crabholes (see below).

4. *Surface Concentrations Associated with Special Physical Characteristics of the Soil.*

Under dry farming conditions in the drier portions of the wheat belt of Western Australia, surface accumulations of soluble salts have been observed in cleared country, particularly on certain soil types, where the surface shows no abnormal irregularities in micro-relief and where no evidence of a water table exists. The soil types most commonly affected have generally a powdery or snuffy structure when dry and are characterised by morrel (*Eucalyptus longicornis*) and associated timbers in the virgin state. The profile consists of a brownish to greyish, calcareous, powdery loam or sandy loam on a light structureless clay or clay loam rich in calcium carbonate. Capillarity is particularly active in these soils and moisture penetration is often somewhat restricted. It is thought that capillary connection between the surface and subsoil is established after soaking rains and this connection becomes more or less permanent in patches. Where the subsoil is saline, surface accumulation of salt occurs in these patches, and this promotes the maintenance of capillary connection by virtue of affinity of the salts for water as suggested by Muntz and Gaudichon (see McCool and Wheeting (1917)).

5. *Surface Concentrations on Areas with Saline Subsoils but without unusual Micro-relief or Structure.*

To a more limited extent similar patches of salt accumulation occur in cleared salmon gum (*Eucalyptus salmonophloia*) country in which the normal soil is typically a brown to reddish brown sandy loam to sandy clay loam on a calcareous sandy clay subsoil whose structure usually shows the normal aggregations. Where surface accumulation of salt occurs, however, the soil structure on the surface breaks down and the patches are indicated by flat areas contrasting with the normal, cloddy surface soils. This effect of salts on the stability of soil aggregates has been discussed by Russell (1932). In salmon gum country occurrences of patches of saline soil are commonly contiguous to areas of light sandy soils at higher levels and it is thought that in these instances a certain amount of seepage from the light soils may be one factor in the formation of these patches.

However, similar saline patches may be observed on the level shelf areas between crabholes as mentioned above and also on areas where there is no possibility of seepage from higher land. As these soils are fairly heavy in texture and

FIGURE 1A.

Diagram showing the distribution of salt in a cleared portion of the Campion calcareous sandy loam (morrel soil) at Welbungin which has become affected by salt accumulation in patches.

B signifies bare area.
G signifies grassy or good area.

FIGURE 1B-1C.

Diagram showing the distribution of salt in cleared soils which have become affected by salt accumulation in patches.

B signifies bare area.
G signifies grassy or good area.

On Figure 1B—
CVs signifies Circle Valley sand.
CVsl signifies Circle Valley sandy loam.
Bsl signifies Beete calcareous sandy loam.

the subsoils rich in sodium and magnesium in the clay absorbing complex, restricted percolation may be a factor in promoting the formation of these saline patches by the action of capillarity. Their occurrence is a fact, however, whatever the explanation, and the concentration is undoubtedly due to capillarity.

The vertical and horizontal distribution of salt in areas in which these patches of saline soils occur in the absence of a shallow water table, seepage or special micro-relief is shown in Figure 1. Figure 1A shows the salt distribution in a

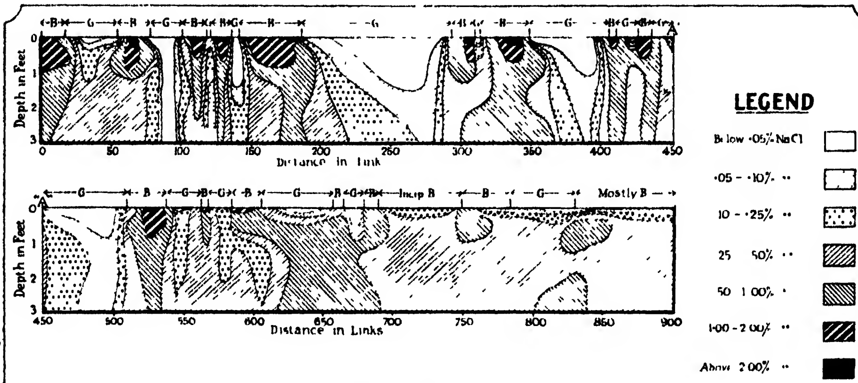


FIG. 1A

AVON LOCATION 14820. WELBUNGIN

April 20, 1932

morrel soil of a powdery structure, the Campion calcareous sandy loam, at Welbungin; Figure 1B shows the salt distribution in a complex of the Beete calcareous sandy loam, the Circle Valley sandy loam and the Circle Valley sand at

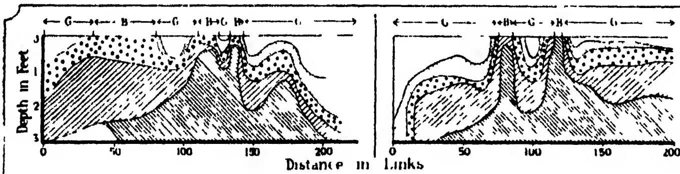
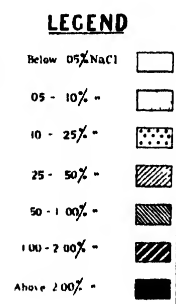


FIG. 1C

YILGARN RES STATION PDK. 1
July 14, 1931



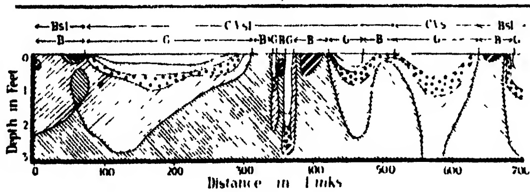


FIG. 1B

LOCATION 24, GRASS PATCH
Nov. 27, 1934

Grass Patch; fig. 1C, the distribution in a salmon gum type on the Yilgarn Research Station at Ghooli. The Beete calcareous sandy loam resembles the Campion calcareous sandy loam, and the Circle Valley types consist of a sandy

surface on a calcareous sandy clay loam. Where the sand is shallow—less than three inches deep—the surface and subsoil are mixed during cultural operations, producing a sandy loam surface texture. This type has been mapped as the Circle Valley sandy loam to distinguish it from types in which the surface sand is deeper.

The diagrams in Figure 1 have been constructed from the results of analyses of soil samples taken at short intervals along lines several chains long through cleared country showing saline bare patches. Generally the surface inch, and the first, second and third foot layers in the profile were sampled at sites representing the soil conditions with respect to structure, growth of grass and obvious salt accumulation.

For Figure 1A the data were obtained on 20th April, 1932, in an area of Campion calcareous sandy loam on Avon Location 14820 near Welbungin. A recent rain had caused the barley grass (*Hordeum murinum*) to germinate and areas showing a growth of these seedlings or a covering of dry barley grass from the previous season are mapped as "grassed" and indicated by the letter G. Bare and crusted areas are indicated by the letter B. Some 48 sites were sampled and 191 samples analysed in the course of this examination and enable a detailed picture to be drawn.

The data for Figures 1B and 1C were obtained in a similar manner. At Grass Patch (Figure 1B) the sampling was made on 27th November, 1934, and at the Yilgarn Research Station (Figure 1C) on 14th July, 1931.

Study of the diagrams shows clearly the wicklike action involved in the movements of the water soluble salts, and demonstrates the occurrence of contiguous vertical columns of saline and non-saline soils. Apparently the conditions following clearing cause the movement downward to take place at one spot while an upward movement with surface accumulation is observed adjacent in certain soil types. In other soil types, *e.g.*, Circle Valley sand, only the downward movement is observed. Just how permanent these patches are under these field conditions has not been determined.

Sampling of virgin country in the same localities shows that prior to clearing a fairly uniform distribution occurs with the surface foot averaging about 0.15 per cent. salt (NaCl), the second foot 0.30 per cent. salt and the third foot 0.40 per cent. salt. The redistribution follows naturally after clearing, especially in the heavier and more powdery, calcareous soil types. It is independent of a shallow water table, as in none of these instances was a water table present within many feet of the surface, and appears to occur within the soil mass to a depth of several feet, probably 5 or 6 feet.

Figure 2 gives additional details concerning one of the bare patches encountered on the line in Figure 1A. The samplings were made as closely as possible to the edge of the barley grass which had grown the previous season (in 1931). These "edge" sites are generally high in salt and would suggest that the area of surface salt accumulation was expanding somewhat.

B.—THE EFFECT OF CLEARING THE NATURAL VEGETATION ON THE MOVEMENT OF SOLUBLE SALTS IN THE SOIL UNDER AN 11 TO 16 INCH RAINFALL.

The discovery that certain soil types in outlying portions of the wheat belt of Western Australia were more or less affected with excessive quantities of soluble salts led to comprehensive soil surveys and reconnaissance surveys in the districts in question. In interpreting the results of the soil analyses it was possible to

FIGURE 2.

Plan of a saline bare patch in Campion calcareous sandy loam (grey, snuffy morrel country) on Avon Location 14820, Welbungin, showing the composition of marginal sites and the central portion. The dead barley grass of the previous season (1931) delineates the boundary of the bare patch. The depths are given in inches and the analyses as per cent. sodium chloride calculated from total chloride.

draw on the experience of farmers in Western Australia and on the information contained in an extensive literature on saline or alkali soils.

All of the practical and scientific evidence led to the conclusion that, under dry farming conditions, where the rainfall ranges from 11 to 14 inches per annum, soils affected with salt in the virgin state must be regarded with suspicion and as more or less unsuitable for wheat production. In the Salmon Gums district, certain soil types which had yielded 15 bushels of wheat per acre at the first crop produced about one-third the crop subsequently, and the failure was directly correlated with soil salinity. At Lake Brown, Newdegate and other centres supporting evidence was available, and it may be asserted that the general conclusion still stands.

The preliminary investigation of cleared and virgin forest country at Lake Brown, which is principally of the medium to heavy textured types, disclosed no

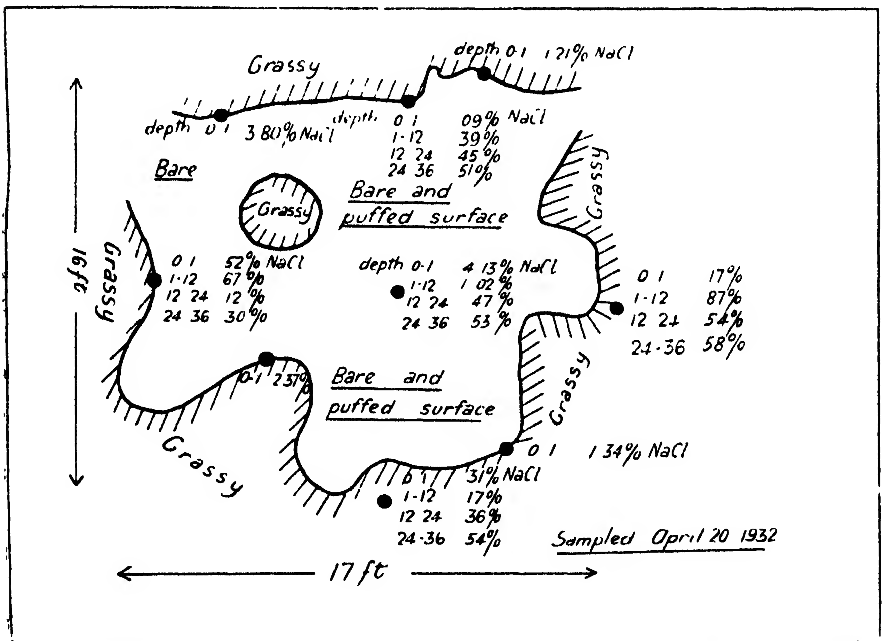


Fig. 2.

evidence of the substantial leaching of salt following clearing. Changes did occur but involved redistributions similar to those described above.

In carrying out the detailed soil alkali survey, however, the soil type was recognised as the unit in classification and the distribution of salt superimposed on the soil type map. This led to the discovery early in the survey at Salmon Gums that certain of the saline soil types varied from the general rule after clearing. It was found that well-drained, sandy-surfaced soil types were readily leached of soluble salts following clearing, but the heavier-textured types, where affected by salt concentration before clearing, failed to exhibit such improvement and generally developed patches showing surface salt accumulation as described above.

To determine the changes in salt status, following clearing over large areas, a study was subsequently made of the analyses of samples from thousands of sites, taken both in cleared and virgin country, in the Salmon Gums area, where the average annual rainfall ranges from 12 inches in the north to 16 inches in the south.

Table 2 represents the incidence of salt at apparently normal sites in virgin and cleared land, taking four distinct groups of soils as representatives of the area. It is seen that, in the virgin state, all groups of soil show a considerable proportion of sites at which the salt (NaCl) content of the surface two feet exceeds 0.22 per cent. This may be taken as the limit below which growth of wheat should not be seriously affected.

TABLE 2.

Effect of Clearing on the Salinity of Soils of various Types in the Salmon Gums Area.

All analyses considered in this table are for "normal" sites; that is, sites not showing surface evidence of salt accumulation.

GROUP A.—Sandy surfaced soils (with sandy clay subsoils) include the Circle Valley sand and Scaddan sand.

GROUP B.—Medium textured soils include the Kumarl sandy loam and the Circle Valley sandy loam.

GROUP C.—Highly calcareous soils—the Beete calcareous sandy loam.

GROUP D.—Heavy textured soils include the Kumarl clay loam and the Dowak clay loam.

Analyses as per cent. Salt (NaCl) in the Oven Dry Soil.

Group.	Condition.	Total Number of Sites.	Percentage of sites within each Range of Salt (NaCl) concentration in the Soil to a depth of two feet.				
			Below 0·13. %	0·13 to 0·17. %	0·18 to 0·22. %	0·23 to 0·29. %	above 0·30 %
A.	Virgin Cleared	4,324 4,255	17·6 78·2	14·9 13·0	20·2 5·7	25·2 1·9	22·1 1·2
B.	Virgin Cleared	1,901 1,998	8·6 45·9	8·7 16·2	15·3 14·2	23·4 11·2	44·0 12·5
C.	Virgin Cleared	1,950 491	10·0 42·6	8·0 14·2	12·7 11·6	18·6 9·0	50·7 22·6
D.	Virgin Cleared	1,237 837	7·0 17·1	6·3 14·7	8·5 15·0	15·6 15·8	62·6 37·4

Of most importance is the distribution of sites according to salt status after the land has been cleared for some years.

The sandy-surfaced types show practically complete removal of deleterious quantities of salt in the surface two feet and, furthermore, as shown in Table 3, a negligible amount of surface accumulation in the form of bare patches occurs. Bare patches associated with salt accumulation are very rarely seen on this group of soils.

A very considerable improvement has taken place in the medium-textured soils represented by the Circle Valley sandy loam and the Kumarl sandy loam (Group B), but still about one quarter of the "normal" sites sampled on cleared country show above 0.22 per cent. salt in the surface two feet. In addition, surface accumulation of salt in bare patches occurs to a certain extent in the types in this group (Table 3), so that recovery may be estimated at about 60 per cent. in the areas affected by high concentrations of salt in the virgin state.

TABLE 3.

Number Sampled and Analyses of Bare Patches suspected of being due to Salt Accumulation in the Principal Soil Types of the Salmon Gums Soil Survey.

Sites in Cleared and Virgin country are segregated for purposes of comparison.

Analyses as per cent Salt (NaCl) in the Oven Dry Soil. Sampling depth is 12 inches.

Soil Type.	Condition.	Total Number of of bare patches sampled.	Percentage of samples from bare patches within each range of Salt (NaCl) concentration to a depth of one foot.					Total Number of sites sampled, including bare patches.	Bare patches as percentage of total sites sampled.
			Below 0.11.	0.11–0.24.	0.25–0.49.	0.50–1.00.	Above 1.00.		
			%	%	%	%	%		
Circle Valley Sand (shallow phase) (Group A)	Virgin ...	3	33	...	...	67	...	2799	0.1
	Cleared ...	24	21	21	21	37	...	2958	0.8
Circle Valley Sandy Loam (Group B)	Virgin ...	5	40	40	...	20	...	993	0.5
	Cleared ...	146	13	22	32	30	3	1638	8.9
Beete Calcareous Sandy Loam (Group C)	Virgin ...	19	5	26	21	27	21	1969	1.0
	Cleared ...	96	5	10	29	45	11	587	16.4
Kumarl-Dowak Clay Loam (Group D)	Virgin ...	24	17	12	8	25	38	1261	1.9
	Cleared ...	166	1	6	30	55	8	1003	16.5

The calcareous-surfaced soils of Group C, as represented by the Beete calcareous sandy loam, resemble somewhat the other sandy loam types of Group B as far as salt distribution in the virgin state is concerned. Improvement after clearing has taken place in the "normal" sites as shown by Table 2 but still over 30 per cent. of the samples fall in the high group (above 0.22 per cent. salt in the surface two feet) as compared with 69 per cent. in the virgin soils. In addition, considerable development of bare patches showing surface accumulation of salt has taken place in this type and from Table 3 it is seen that most of these bare patches are very high in salt. This is probably due to the superior capillary properties of the soils of this group. As field observations suggest that in this soil type the bare patches are even more important than is indicated by the proportion of bare patches sampled, and normal sites retain a considerable proportion of salt, areas of this type where saline in the virgin state must still be regarded as subject to serious reduction in value for wheat production if brought under cultivation. Recovery following clearing may be estimated at less than 50 per cent. Furthermore, the Beete calcareous sandy loam, known locally as "Kopi" soil in the Salmon Gums district, is found to be unsatisfactory for wheat-growing under low rainfall conditions, even where free of salt, and must be regarded as an unsatisfactory type generally for development for wheat farming.

The heavy-textured soils of Group D, including the Kumarl clay loam and the Dowak clay loam, are by far the most saline soils in the virgin state and from the evidence available show an inconsiderable improvement (probably not more than 25 to 30 per cent.) in normal sites after clearing. Furthermore, these types, and more particularly the Dowak clay loam, are very subject to the development of bare patches, showing, as indicated in Table 3, considerable salt accumulation. Development of saline bare patches has even occurred to a small extent under virgin conditions in this group.

Surface accumulation of salt in these types of this group has occurred both on the rims of crabholes and on the areas showing no evidence of micro-relief. In many instances, the incidence of bare patches alone seriously reduces the yield of wheat crops. This reduction is difficult to estimate, as the proportion of bare patches sampled is only a slight index of their relative abundance in cleared country. The soils of this group have proved generally unsatisfactory for wheat-growing for a number of reasons, of which soil salinity is one of the most important. Fortunately, investigations at the Salmon Gums Research Station indicate that Wimmera Rye Grass and certain salt bushes of high salt tolerance may do much toward the profitable utilisation of these soils and may even promote more substantial reclamation. (Teakle (1937).)

Leaching of Salt following clearing of the Circle Valley Sand.

The question of the leaching of the soluble salts was investigated in greater detail in selected sites in the Circle Valley sand. In the first place clearing lines in a uniform area of the type were selected in two places on location 588, East Dowak, and series of samples taken along lines 3 chains apart:—

(a) 1½ chains within the virgin timber;

(b) 1½ chains within the clearing.

The results are given in Table 4 and are characteristic of other investigations of a similar nature on this soil type. There is no doubt that general and substantial leaching of water soluble salts has occurred following clearing.

In the second place, pairs of type samples to a depth of 15 to 20 feet were obtained from sites in virgin and cleared Circle Valley sand on Fitzgerald location

588, East Dowak, and Fitzgerald Location 422, East Circle Valley. The sites in virgin country were one to one and a half chains within the undisturbed timber and the sites in cleared country directly opposite and a similar distance from the edge of the clearing. The soil profiles were as similar as could be expected in both pairs of sites. On Fitzgerald Location 588 the land had been cleared two years and on Fitzgerald location 422, five years.

TABLE 4.

Salt (sodium chloride) content of samples from adjacent virgin and cleared areas of the Circle Valley sand on Fitzgerald Loc. 588, East Dowak. Each figure is the average of several samples and the percentage is calculated to the oven-dry soil basis.

Series.	Condition of Country.	Number of Sites.	Per cent. Salt with Depth in Oven-dry Soil.				
			Surface Sand.		Sandy Clay Loam to Sandy Clay.		
			0in.—1in.	1in.—3in.	3in.—12in.	12in.—18in	18in.—24in.
I.	Virgin	6	0·003 (·002—·005)	0·009 (·003—·023)	0·232 (·110—·387)	0·373 (·245—·453)	0·437 (·343—·520)
	Cleared	6	0·003 (·003—·008)	0·008 (·002—·020)	0·017 (·008—·042)	0·039 (·012—·088)	0·070 (·035—·130)
II.	Virgin	7	0·02		0·16 (·06—·24)	0·39 (0·27—·53)	
	Cleared	7	0·02		0·04 (0·01—0·10)	0·11 (·01—·27)	

The vertical distribution of the salt in the profiles is represented in Figure 3 and shows that considerable displacement downwards has followed the clearing of the land. While the possibility of soil variability being an important factor in leading to this difference must be considered, a great deal of collateral evidence obtained in the course of the soil survey indicates that the observed difference is at least largely the result of leaching following clearing.

Some measure of the original degree of similarity of the sites of each pair may be gauged from a consideration of the total salt contents of the profiles. Assuming that an acre foot of soil weighs 1,560 tons the amounts of salt in each profile in tons per acre to the depth specified are as follows:—

Fitzgerald Location 588 (19 feet deep).		Fitzgerald Location 422 (15 feet deep).	
Virgin— 173 tons	Cleared— 167 tons	Virgin— 129 tons	Cleared— 112 tons

When the natural variability of soils is considered it can be concluded that the sites in each pair were closely similar prior to clearing.

If it be assumed that the sites of each pair were identical prior to clearing it may be observed from Figure 3 that displacement has occurred to a depth of 3½ feet on Fitzgerald location 588 (in the course of two years) and to a depth of 6 feet on Fitzgerald location 422. On the same assumption this displacement is reflected

by an approximately equivalent concentration in the substratum on Fitzgerald location 588. On Fitzgerald location 422 the evidence for the concentration in the substratum is inconsequential and study of the salt profiles suggests that originally the

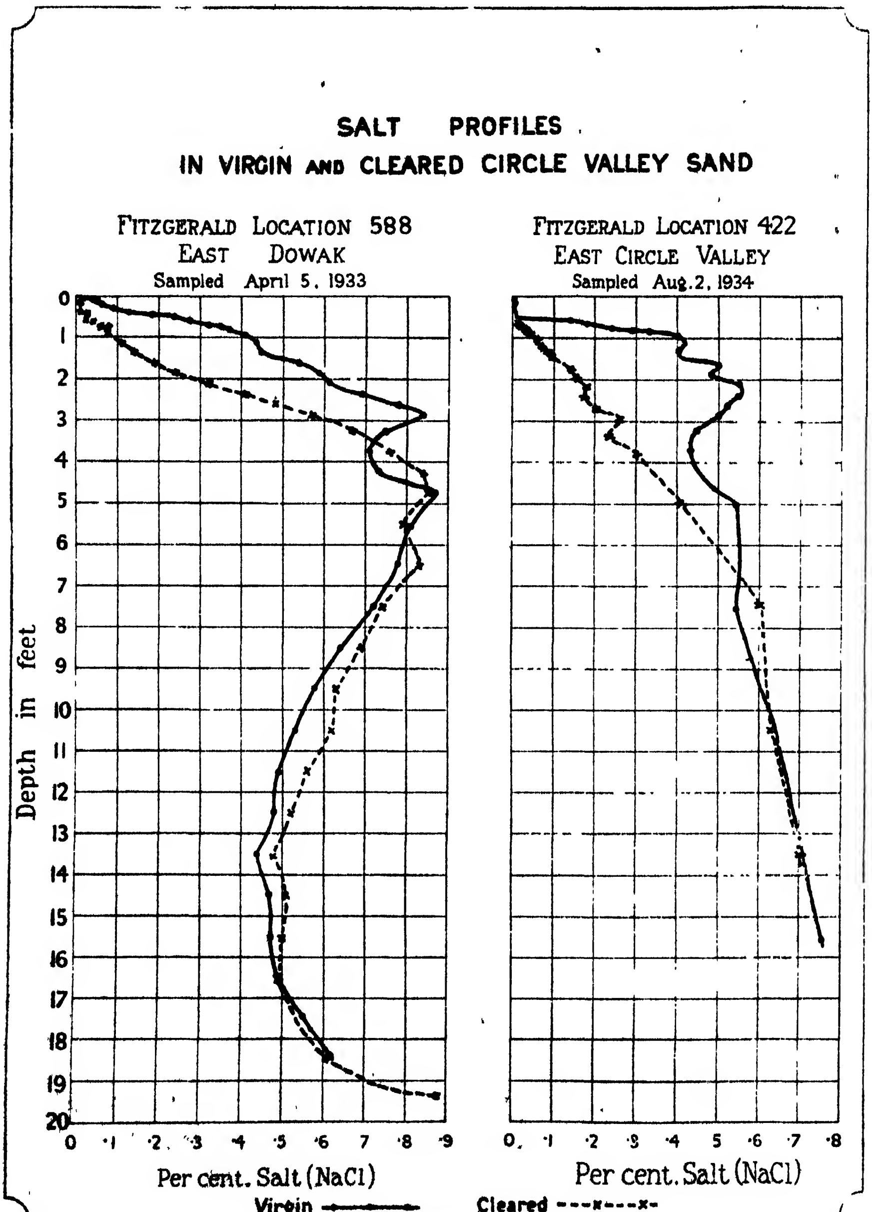


Fig. 3.

site now in cleared country was 10 to 15 per cent. less saline than its pair. The assumed "losses" and "gains" in the various portions of the profiles are given in Table 5. Also, by way of comparison it is assumed that the site in cleared country

on Fitzgerald location 422 originally contained 13 per cent. less salt uniformly throughout the profile than its pair. The figures from this computation are included in Table 5.

TABLE 5.

Apparent displacement of Salt (NaCl from Cl) in the profiles of adjacent cleared and virgin sites in the Circle Valley sand on Fitzgerald Locations 588 and 422.

Fitzgerald Location 588 (Cleared 2 years).			Fitzgerald Location 422 (Cleared 5 years).				
Depth of Zone (feet).	Assumed gain or loss of salt in the cleared soil in terms of tons per acre.		Depth of Zone (feet).	Assumed gain or loss of salt in the cleared soil in terms of tons per acre.		Assumed gain or loss of salt in the cleared soil if the salt concentration were originally 13 per cent. less than in the present virgin site—in terms of tons per acre.	
	gain.	loss		gain.	loss.	gain.	loss.
0 —3½	...	13 tons	0 — 6	..	19·5 tons	...	14·0 tons
3½—4½	1·2 tons	...	6 — 9	2·7 tons	...	6 1 tons	..
4½—6	...	0·5 tons	..	...	...	..	
6 —16	7·5 tons	..	9 — 15	...	0·5 tons	7·9 tons	..
Error	4·8 tons		...	17·3 tons		..	

There is no doubt that substantial leaching of salt has taken place in the Circle Valley sand and the quantity removed from the upper portions of the subsoil amounts to 10 to 20 tons per acre. This would be about half of the content in the virgin state and the loss is incurred in a surprisingly short period of years.

Moisture determinations were made on the samples from Fitzgerald Location 422 with the results as given in Table 6.

TABLE 6.

Moisture Content of Soils from sites in virgin and cleared Circle Valley Sand on Fitzgerald Location 422. Sampled 2nd August, 1934.

Depth.	Virgin. Moisture %.	Cleared. Moisture %.
Inches.		
0—6	1·8	8·1
6—12	10·3	14·2
12—24	12·7	15·9
24—36	13·5	17·2
36—48	12·4	14·9
Feet.		
4—6	14·7	15·7
6—9	15·1	17·1
9—12	17·1	16·3
12—15	17·2	16·7
15—16½	19·7	...

The deeper subsoil layers in the virgin soil were distinctly moist but in the cleared area the moisture was apparent below the first foot. The relation between these moisture contents and such constants as the moisture equivalent or sticky point has not yet been determined.

The effect of leaching on the composition of the water soluble salts.

The composition of the water soluble fraction changes significantly in the course of the leaching following clearing in any soil type subject to the process. This was shown primarily by the relation between electrical resistance of the soil suspension and chloride content. This ratio is wider in the leached soils and indicates the greater mobility of chloride as compared with other ions. From the results of chemical examination of the water soluble fraction, it appears that bicarbonate takes the place of the chloride removed in excess of cations.

The relation between chloride and specific resistance in virgin and cleared soils is indicated in Table 7, and in Table 8 is shown the chemical composition of the

TABLE 7.

The relation between the specific resistance of the 1 : 5 soil : water suspension and salt content of a large number of sites in virgin and cleared country at East Dowak, 22nd May to 11th September, 1933. (Salt content is calculated from chloride.)

Specific Resistance (ohms at 60° F.)	Salt content (per cent. NaCl in oven-dry soil) Virgin Sites.	Cleared Sites.
700	0·35	0·34
750	0·32	0·31
800	0·30	0·28
850	0·28	0·25
900	0·26	0·23
950	0·25	0·21
1000	0·23	0·20
1100	0·21	0·18
1200	0·19	0·16
1300	0·17	0·14
1400	0·16	0·12
1600	0·13	0·10
1800	0·11	0·08
2000	0·10	0·07
2200	0·09	0·06
2400	0·08	0·05
2600	0·07	0·04

water soluble salts in virgin and cleared soils using the samples from the sites in the Circle Valley sand types discussed above. Figure 4 graphically illustrates the changed relation between total water soluble salts and salt in the leached layers. In Table 9 is shown the relation between the ions determined in the water soluble salts and reported in Table 8.

It should be pointed out that calcareous nodules and soft calcium carbonate also occur in these profiles from about 6 to 9 inches to 5 feet deep (9 feet in the case of Location 442). The deeper layers are not only non-calcareous, but are strongly acid in reaction.

On account of their very low soluble salt content no data are presented for the surface sands. The sand layer was four inches deep in the profiles from Fitzgerald Location 588 and 6 to 7 inches deep from Fitzgerald Location 442. On account of the very low chloride content of the clay immediately below the sand in the cleared site on Location 422, this layer was not examined for the composition of the water soluble salts.

First, to consider the results from the work on Fitzgerald Location 588, from Table 9 it is seen that the ratio of bicarbonate to chloride in the subsoil to a depth of 3 feet in the cleared soil is from 5 to 8 times that for the same layers in the virgin soil and similarly the ratio of bicarbonate to sodium and to total water soluble salts has considerably increased following clearing—1½ to nearly 3 fold.

If, as seems reasonable, it be assumed that the 4-17 inch layer in the virgin soil and the 4-13 inch layer in the cleared soil were originally comparable, the proportion of chloride in the total water soluble salts has dropped from an average of 32.7 per cent. in the virgin soil to 10.8 per cent. in the cleared land, while the proportion of bicarbonate has increased from 25.8 per cent. to 49 per cent. Sodium appears to move slightly faster than the total water soluble salts as the proportion in the total water soluble salts has decreased from 31.4 per cent. in the virgin soil to 28.2 per cent. in the cleared soil. The proportion of sulphate shows a significant decrease in the cleared soil in this case.

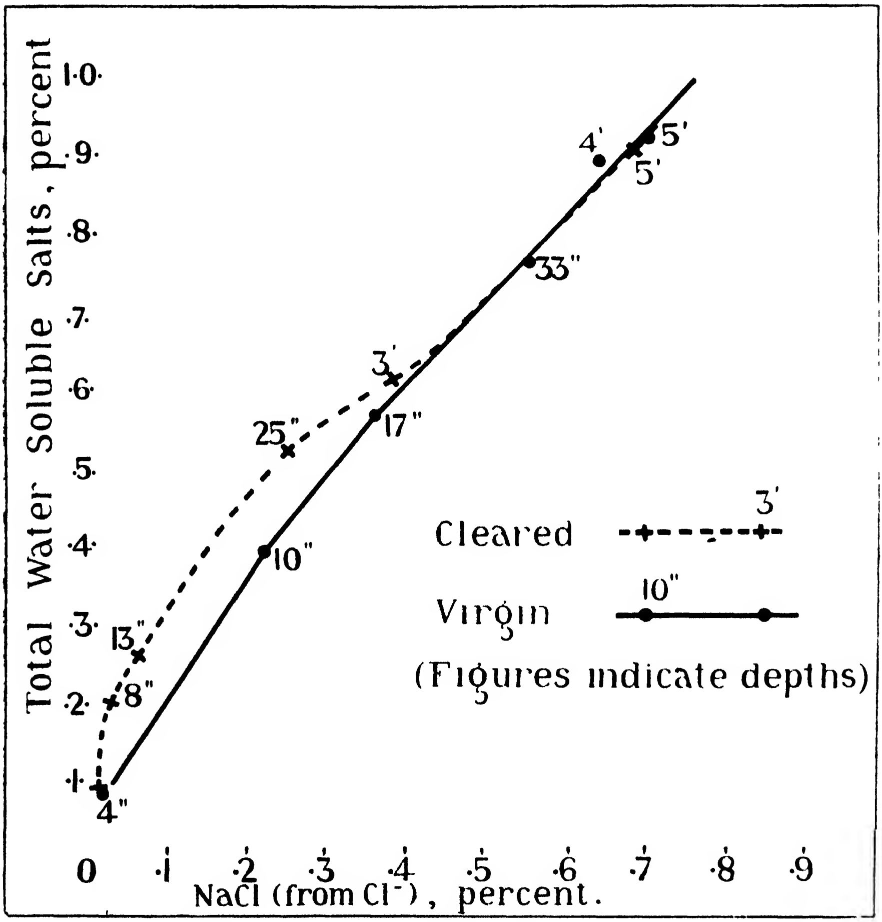


FIGURE 4.

Graph showing relation between Total Water Soluble Salts and salt (NaCl calculated from chloride) in virgin and cleared Circle Valley sand as represented by the type samples on Fitzgerald location 588.

In patches where surface accumulation of soluble salts occurs, a reversal of the above relationships is indicated for chloride, as conductivity and chloride titration determinations show an increased percentage of chloride in the water soluble salt fraction. Apparently the chloride ion is the most mobile in the soil and the property is expressed whether the movement be upwards or downwards.

TABLE 8.

The constituents of the Water Soluble Salts of Virgin and Cleared Soils of the Circle Valley sand type.

Results expressed as per cent. of the oven-dry soil.

Serial Number.	Depth.	T.W.S.S.*	Sodium. Na	Potassium K.	Magnesium Mg.	Calcium Ca.	Sulphate SO_4	Nitrate NO_3.	Carbonate CO_3.	Bicarbonate HCO_3	Chloride Cl.
	inches.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
A.—Samples from Fitzgerald Location 588.											
Virgin Soil—											
853	4 to 10	·456	·130	006	·003	002	·028	005		·149	·133
854	10 „ 17	·602	206	·007	·003	·002	·049	·004		·113	·218
855	17 „ 33	·832	·324	·008	005	·003	076	·006		·075	·335
Cleared Soil—											
866	4 „ 8	·196	·052	·009	·002	·003	·008	·005		·098	·019
867	8 „ 13	·331	·099	007	·001	002	·015	·009		·159	·039
868	13 „ 25	·517	·155	·007	·001	·002	·043	·007		·151	·151
869	25 „ 36	·649	·246	·011	·002	·003	·076	·006		·073	·232
B.—Samples from Fitzgerald Location 422.											
Virgin Soil—											
1117	12 to 24	·625	·220	·007	·003	·008	·043	·003	·006	·066	·269
1118	24 „ 36	·669	·237	006	·004	005	·053	·001	·005	·063	·295
1121	72 „ 108	·699	·250	·006	·003	·003	·059	·002	·004	·050	·322
1123	144 „ 180	·792	·282	·008	·005	002	·070	·002	*Nil*	·006	·417
Cleared Soil—											
1127	13 „ 25	·342	·108	·002	·001	·002	·022	·003	·024	·106	·074
1128	25 „ 37	·452	·135	·011	·002	·002	·039	·002	·005	·131	·125
1131	72 „ 108	·768	·247	·011	·005	·008	·073	·002	*Nil*	·062	·360
1133	144 „ 180	·764	·257	·014	·008	·001	·062	Tr.	*Nil*	·002	420
Sea Water		3·48	1·03	·06	·13	·05	·28				1·90

Analyst—F. F. ALLSOP.

* Total water soluble salts (T.W.S.S.) is obtained in this instance by addition of the ions determined by analysis as CO_2 is lost in the determination of T.W.S.S. by the usual gravimetric method.

TABLE 9.

Relation between Constituents of the Water Soluble Salts of Virgin and Cleared Sites in the Circle Valley Sand from information reported in Table 7.

Ratios expressed as per cent.

Serial Number.		Na.	Cl.	HCO_3. †	SO_4.	Cl.*	HCO_3.†	HCO_3.†	T.W.S.S., per cent. dry soil.
	Depth (inches).	T.W.S.S., per cent.	T.W.S.S., per cent.	T.W.S.S., per cent.	T.W.S.S., per cent.	Na, per cent.	Na, per cent.	Cl, per cent.	
A.—Samples from Fitzgerald Location 588.									
Virgin Soil—									
853	4—10	28·5	29·2	32·8	6·1	102	115	112	·456
854	10—17	34·2	36·2	18·8	8·1	106	54·9	51·8	·602
855	17—33	38·9	40·3	9·0	9·1	103	23·1	22·4	·832
Cleared Soil—									
866	4—8	26·5	9·7	50·0	4·1	36·6	188	516	·196
867	8—13	29·9	11·8	48·0	4·3	39·4	161	408	·331
868	13—25	30·0	29·4	29·4	8·3	97·4	97·4	100	·517
869	25—36	37·9	35·8	11·2	11·7	94·3	29·7	31·4	·649
B.—Samples from Fitzgerald Location 422.									
Virgin Soil—									
1117	12—24	35·2	43·1	12·5	6·9	122	35·5	29·0	·625
1118	24—36	35·4	44·1	10·9	7·9	125	30·8	24·4	·669
1121	72—108	35·8	46·1	8·3	8·4	129	23·2	18·0	·699
1123	144—180	35·6	52·7	0·8	8·8	148	2·1	1·4	·792
Cleared Soil—									
1127	13—25	31·6	21·6	45·3	6·4	68·5	144	210	·342
1128	25—37	29·9	27·7	31·2	8·6	93	104	113	·452
1131	72—108	32·2	46·9	8·1	9·5	146	25·1	17·2	·768
1133	144—180	33·6	55·0	0·3	8·1	164	0·8	0·5	·764
Sea Water	...	29·6	54·6	?	8·0	184	?	?	3·48

* Ratio Cl to Na in common salt (NaCl) = 154 per cent.

† CO_3 is converted to an equivalent weight of HCO_3 by multiplying by 2·03 and added to the HCO_3 determined.

The evidence from Fitzgerald Location 422 supports the above conclusions and serves to amplify that from Fitzgerald Location 588 on account of the examination of samples from deeper layers—and into the strongly acid substrata below 12 feet deep.

As discovered for the sites from Location 588, throughout the profile calcium and magnesium are quite low but potassium seems very well supplied in the water soluble form. In the deep layers from the sites on Location 422 sodium and chloride approach molecular proportions and, as would be expected from the acidity, bicarbonate is almost non-existent.

In comparison with the salts of sea water, these soil salts contain a somewhat lower proportion of potassium, and the calcium ratio and the magnesium ratio are considerably lower. The proportion of sodium is somewhat greater and that of chloride is generally lower in the surface but closely approaches the proportion of sea salt in the deeper layers. The proportion of sulphate is approximately the same as in sea water in 3 of the 4 sites. In spite of the divergences, it can well be, however, that these salts are of marine origin, probably derived from the rainfall, and have been slightly modified in composition by reaction with the soil. For instance, the high proportion of replaceable magnesium in these soils may be partly the result of reaction between the soil and the cyclic salts.

The two maxima shown in the graph (Fig. 3) of the salt profiles are of considerable interest and represent a very common feature of salt profiles in the Salmon Gums area. This matter will be discussed in a later paper but it may be mentioned that in the case of the samples from Fitzgerald Location 588 in the virgin profile, the subsoil was visibly moist below 33 inches, the depth of the first maximum. In the cleared profile the soil was moist from 8 inches deep. The layer between one and three feet deep was wet and sticky to the feel, and the deep subsoil (below 5 feet) appeared slightly more moist than in the virgin profile. This observation correlates with a higher salt content in the deep subsoil of the cleared profile but, unfortunately, no facilities for moisture estimations were available at the time and precise data cannot be given. The information from Fitzgerald Location 422 does not appear to offer any clarification of the phenomenon.

C. MOVEMENT OF SALT IN TANKS AT THE MERREDIN RESEARCH STATION.

While the field data provide convincing evidence of the rapid leaching of water soluble salts in sandy surfaced soils after clearing under relatively low rainfall conditions (11 to 16 inches per annum) and of substantial improvement in medium textured soils of the sandy loam class the evidence from tank experiments under controlled conditions was studied as a check.

On 30th and 31st March, 1931, four tanks, each about 6 feet deep and 3 to 4 feet in diameter, were filled with sandy clay loam soil typical of the surface 9 inches of the soil of the Merredin Research Station.

The soil was tightly packed into the tanks when in an air dry condition and in three of the tanks three-inch layers consisting of commercial calcium chloride mixed with about 6 parts of soil were interposed. The object of the experiment was the determination of the effect of the natural rainfall on the movement of the chloride in the soils under the conditions of the wheatbelt. The annual rainfall at the Merredin township averages 13.24 inches.

At the outset the condition in the tanks was as follows:—

Tank 1. Control; no calcium chloride.
Tank 2. Calcium chloride—soil mixture at 3-6 inches from the surface.
Tank 3. Calcium chloride—soil mixture at 9-12 inches from the surface.
Tank 4. Calcium chloride—soil mixture at 21-24 inches from the surface.

Samples of soil taken from the heap of soil prior to filling the tanks gave the following results on analysis:—

Sample.	Moisture per cent. oven-dry Soil.	Salt (NaCl) calculated from Chloride (per cent. oven-dry Soil.)
1	8 36	0·043
2	7·71	0·038
3	7·50	0·028
4	5·50	0·018
5	5·75	0·013

The tanks were placed in the open, weeds destroyed (weeds grew on Tank No. 1 during the first winter owing to an oversight), and a shallow loose mulch about one inch deep maintained at the surface.

As the soil is of the calcium-magnesium type with respect to replaceable bases, calcium chloride, and not sodium chloride, was used as a source of chloride, because the effect of sodium salts on the soil might have been the destruction of the structure on leaching and hence the restriction of percolation. It was also realised that the soils in the tanks would not exactly simulate the natural soil conditions as temperature changes would be more marked and this would affect the loss of moisture by vaporisation. There is reason to believe, however, that the behaviour of chloride in the tank soils will closely resemble that which would be observed under field conditions.

The tanks were sampled twice per year; in August or September to show the conditions following the winter rains and in February or March after several months of hot, dry summer weather. Sampling was accomplished by means of a spatula in the surface layers to a depth of about 8 inches and in the deeper layers by means of a modified wood auger inserted into the side of the tank at the desired depth. In taking the samples with the auger the peripheral 6 inches were discarded and the material for testing taken from the soil between 6 and 18 inches of the side of the tank. Moisture, conductivity of the 1:5 soil: water suspension and chloride were determined on each sample. The distribution of salt (NaCl calculated from chloride) in the tanks is shown in Figure 5.

In studying the distribution of salt with the progress of time the factor of variability must be recognised and due caution used in arriving at conclusions. Channelling and less pervious patches in the soil mass will lead to apparent fluctuations which are of no significance.

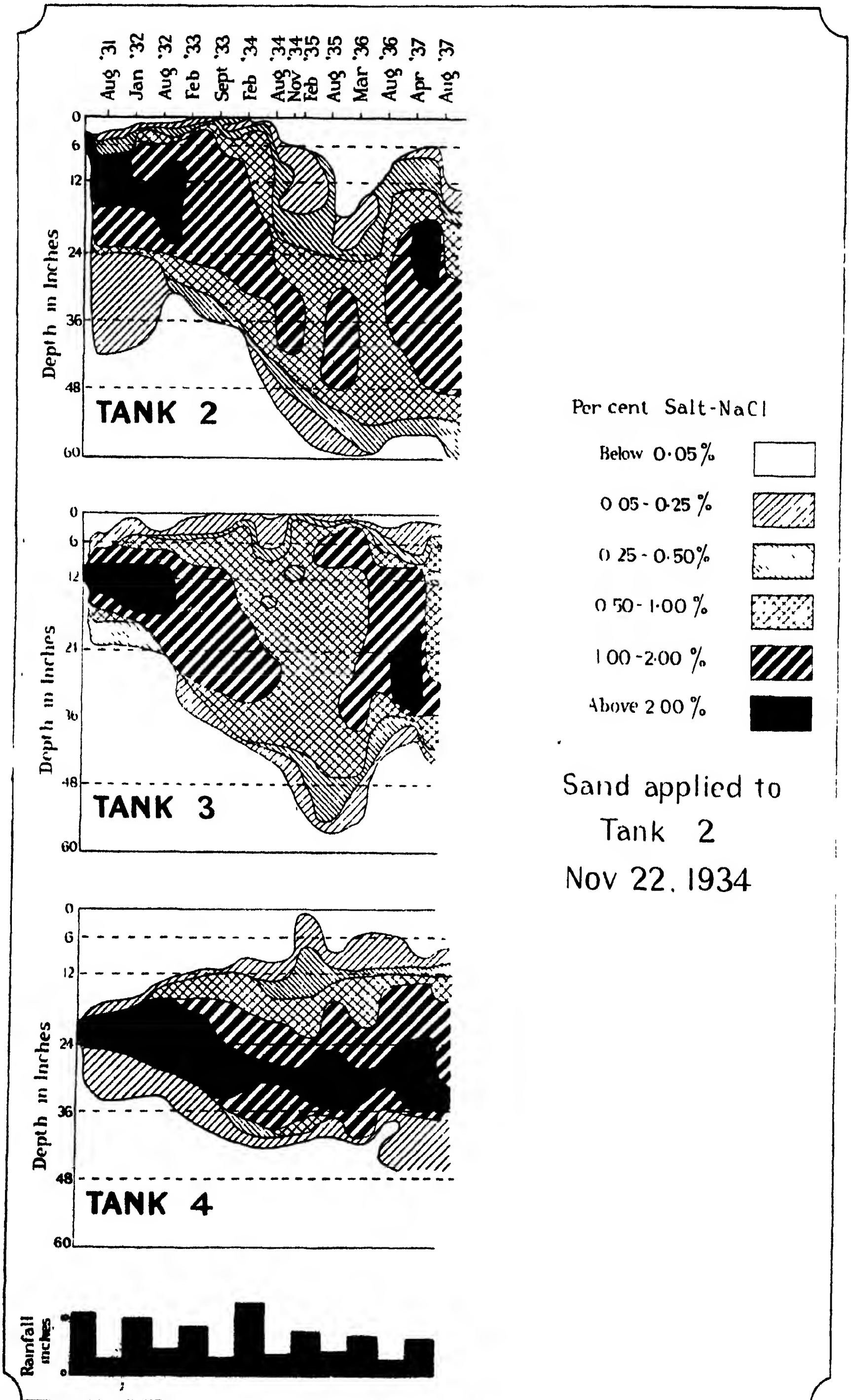
It is clear, however, that movement of salt both upwards and downwards has taken place and, further, that the downward movement is considerably greater than the upward.

In August, 1937, six years after the commencement of the experiment the situation was as follows:—

TABLE 10.

	Tank 2*	Tank 3.	Tank 4.
Salt layer (inches)	3–6	9–12	21–24
Salt above zone of application (per cent. of total salt)	Trace	10 8	29·4
Salt at zone of application (per cent. of total salt)	Trace	2·4	8·9
Salt below zone of application (per cent. of total salt) ...	100	86·8	61·7
Salt below 24-inch depth (per cent. of total salt)	87	63·3	61·7

* A five-inch sand layer was applied to this tank on 22nd November, 1934.



Aug '31
Jan '32
Aug '32
Feb '33
Sept '33
Feb '34
Aug '34
Nov '34
Feb '35
Aug '35
Mar '36
Aug '36
Apr '37
Aug '37
Depth in Inches
TANK 2
TANK 3
TANK 4
Rainfall inches
Per cent Salt-NaCl
Below 0·05 %
0 05 - 0·25 %
0 25 - 0·50 %
0 50 - 1·00 %
1 00 - 2·00 %
Above 2 00 %
Sand applied to Tank 2 Nov 22, 1934

Fig. 5.*

In tanks 3 and 4 approximately the same proportion, namely about two-thirds of the amount of salt in the profile, has moved below the two-feet level.

In the case of Tanks 2 and 3, by August, 1934, the salt profile in each was practically identical. This fact was taken advantage of and the top five inches of

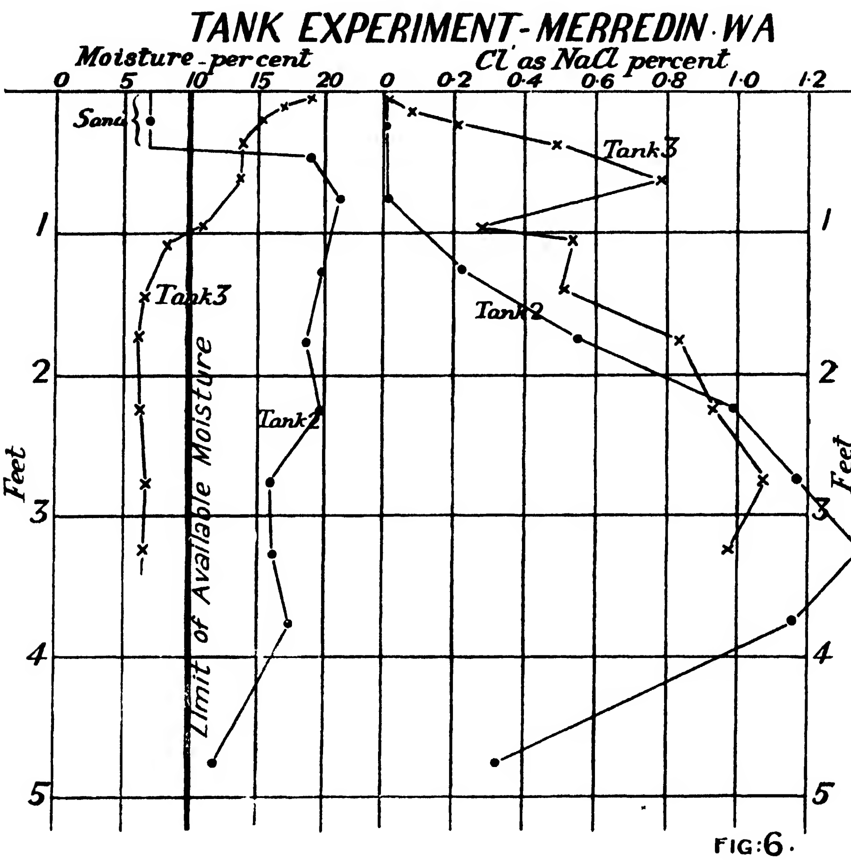


FIGURE 6.

The distribution of salt and moisture in Tank 2 (with a sandy surface) and Tank 3 on 27th August, 1937. The limit of "available" moisture is assumed to be 10 per cent.

soil in Tank 2 was removed and replaced by a like depth of loose sand on 22nd November, 1934. This profile now resembled the Circle Valley sand in textural features and it was interesting to observe that leaching of the chloride was immediately accelerated and at the occasion of the August, 1937. sampling 87 per cent. had been driven below the two-feet mark. Chloride concentration was observed at the 57-inch mark.

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*FIGURE 5.

Movement of salt in soils in tanks exposed to natural wheatbelt conditions at the Merredin Research Station. Layers of salt (using calcium chloride) were placed at varying depths in the profile and the subsequent distribution of chloride determined. A 5-inch layer of sand was placed on top of the soil in Tank 2 on 22nd November, 1934.

Tank 2. Salt layer at 3-6 inches.
Tank 3. Salt layer at 9-12 inches.
Tank 4. Salt layer at 21-24 inches.

This sandy surface was valuable in promoting moisture retention and thereby promoted the leaching of salt. Calculating the soil moisture to a depth of 45 inches in terms of inches of rainfall on August 27th, 1937, Tank 2, with the sandy surface, contained 9 inches, Tank 3, 5.2 inches and Tank 4, 4.9 inches of rain.

Burvill (1930) reports the wilting point of a sample of surface soil from the Merredin Research Station to be 11 per cent. As the soil used in these tanks would closely resemble this sample, it seems reasonable to assume that the moisture in excess of 10 per cent. of the dry soil would be available for plant growth. On this basis the "available" moisture in the tanks on 27th August, 1937, would be—

Tank 1.	... ...	... 0·40 inches "available" water.
Tank 2.	(Sandy surface)	... 4·38 inches "available" water.
Tank 3.	... ...	... 0·56 inches "available" water.
Tank 4.	... ...	... 0·64 inches "available" water.

Furthermore, in Tank 2 with the sandy surface, the "available" moisture extends at least to a depth of 45 inches* while in the others the maximum depth of the "available" moisture is one foot. (See fig. 6.)

Thus the sandy surface has led to the accumulation of about 8 times as much "available" moisture as in the adjacent tanks even though all tanks were maintained under bare fallow conditions.

This experiment lends strong support to the field observations in showing the leaching effect of a low rainfall on a fallowed soil which has a sandy surface to promote water absorption, and to limit surface evaporation. It is also valuable in showing that the dominant movement of salt under these conditions is downward and that salt in the subsoil at a depth of several feet is unlikely to affect the surface in normal well drained soils of the Western Australian wheat belt.

SUMMARY AND CONCLUSIONS.

1. A review of the information in the literature concerning water movements in soil is made as a basis for the discussion of the movement of water soluble salts.

2. It is concluded that movement of moisture by capillarity is effective over short distances only.

3. In general capillarity would not be expected to raise water and, therefore, salts from a depth greater than 4 to 10 feet depending on the soil texture, and movement occurs rapidly only when the soil is quite moist—when it is at or above field capacity. A salt water table at less than 10 feet below the surface may thus allow the deposition of water soluble salts on the surface of the soil as a result of evaporation of water raised by capillarity.

4. In the light rainfall areas of Western Australia salt accumulation in the surface soils is observed—

(a) Where the salt water table is shallower than about 10 feet. The situation is very serious where the depth of the water is shallower than 5 feet.

(b) Where seepage occurs and evaporation of water leaves the residue of salt in the soil.

* An additional amount of 0·80 inches of "available" moisture was present in Tank 2 between the 45 inch level and 5 feet.

(c) On the rims of crab-holes where the micro-relief favours surface evaporation.

(d) Where special soil characters, in the absence of a shallow water table, lead to the establishment of capillary connection between a saline subsoil and the surface.

5. Diagrams have been constructed to illustrate the distribution of salt in soils where surface accumulation occurs in bare patches. The wick-like action involved in the upward and downward movement of salt is apparent. Soils of the morrel class, in which a powdery structure occurs, are most liable to surface accumulation of salt under these conditions. Similar accumulations occur on heavy-textured soils, but less commonly.

6. The effect of clearing on the movement of sa t in saline soils under light rainfall conditions is discussed and it is shown that soil type is of paramount importance in determining the behaviour subsequent to clearing:—

(a) Sandy-surfaced soils with sandy-clay subsoils rapidly lose salt by leaching after the vegetation is cleared. From 10 to 15 tons of salt per acre may be removed from the upper three or four feet in the course of about two years after clearing.

(b) Medium-textured soils, for example, sandy loams, show substantial reduction in salt content or improvement in salt status following clearing.

(c) Heavy-textured soils and powdery soils of the morrel class show little reduction in salt concentration under ordinary farming conditions and are liable to surface accumulation of salt resulting in the appearance of sterile bare patches following clearing.

(d) Chlorides are leached most readily of all common ions in the water soluble salts and electrostatic balance is maintained by the formation of bicarbonates in the zone of leaching.

7. The results of a study of soils in tanks under a 13-inch annual rainfall support the field observations and show that under continuous fallow conditions—

(a) The main movement of water soluble salts in the profile is downwards.

(b) Where a saline layer is initially near the surface, sufficient upward movement may occur to be deleterious to crop growth.

(c) A sandy surface promotes moisture absorption and storage and hence greatly accelerates downward movement of salt.

8. A soil with a light-textured surface is most economical of moisture and is most suitable for agriculture under very low rainfall conditions.

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TRIALS WITH PASTURE AND FODDER SPECIES AND STRAINS AT DENMARK RESEARCH STATION.

H. G. ELLIOTT,

Agricultural Adviser (Dairy Branch).

During the past season at the Denmark Agricultural Research Station a number of species and strains of pasture and fodder plants, which were obtained from various sources in Australia and overseas, were grown for the purpose of determining their growth, productiveness, and value, together with their immunity, if any, to attacks of the lucerne flea and red-legged earth mite.

Of the fodder plants, the most outstanding was the "Bell Windsor" variety of small seeded horse bean, the seed of which was obtained by Dr. T. Dunne originally from California and grown at the Muresk Agricultural College during 1936.

Last season approximately 1/15th of an acre of these beans was grown. They were sown during the second week of May in rows 3 feet apart. The seeding rate was 40 lbs. per acre, and superphosphate was applied at the rate of 2 cwts per acre.

Inter-cultivation to control weeds was carried out twice prior to the plants becoming too high for further cultivation.

In the earlier stages, the young plants suffered from the ravages of the lucerne flea and red-legged earth mite. The effects of these pests were noticeable on the leaves to a height of 15 inches until October.

Flowering commenced on the 21st August when the plants were 3 to 3½ feet high, and by the end of October the average height was 6 feet and flowering completed.

The plants averaged three stems with at least 50 pods per stem. When harvested it was estimated that the yield was over 60 bushels per acre.

Horse or tick beans thrive best on medium to heavy soils but will grow well on most well drained soils. The best method of sowing is in drills about 30 inches apart, the seeding rate between 40 to 60 lbs. per acre. Autumn and early winter is the best time for sowing. A simple method of seeding is to lightly plough in the seed every third or fourth furrow. It is necessary to give at least one inter-cultivation. These beans are such prolific yielders that they amply pay for any time and cultivation expended.

Tick beans are grown in this State principally for a green manuring or soiling crop in orchards, etc., but they can be grown for pig fodder or mixed with cereals for silage and may take the place of peas to some extent in the South-West, as they are not affected by the pea weevil.

At present all the seed sown is imported from the Eastern States.

Small experimental areas of these beans are being established in various centres in the South-West this season.

Of the other fodder plants grown, good results were obtained from the following:—

FIELD PEAS.—"Austrian Winter Pea" (*Pisum arvense*).

This is a white flowered variety which matures slightly earlier than the "Brunswick White" or "Dunn Field Peas." In the seedling stages it was noted that the "Austrian Winter Pea" was not as severely attacked by the red-legged earth mite and lucerne flea as other field peas. In the latter stages it was only slightly affected.

"The Austrian Winter Pea" is a vigorous grower and produces a heavy bulk of green material and is a prolific yielder of seed. It, however, was found that, like other peas of the genus *"Pisum,"* it is severely damaged by the pea weevil. Further trials with this pea will be conducted this season.

VETCHES.—*Vicia spp.*

Of the seven species grown, three were outstanding:—

(a) *Grey Seeded Vetch.*

This is a late-flowering vetch. It was planted on 16th May but did not commence flowering until the first week of November. In the early stages the growth was prostrate, and the young plants were only slightly affected by the red-legged earth mite and lucerne flea. During the latter part of the season, this vetch produced a very heavy bulk of green material.

(b) *Vicia atropurpurea.*

This is also a late species with a more upright growth habit than the Grey Seeded Vetch, but produces a very heavy bulk of green material and was only slightly affected by the lucerne flea and red-legged earth mite.

(c) *Vicia sativa.*

Another late-flowering and maturing variety which was severely attacked by both the lucerne flea and red mite in the early stages of growth, but, when the growth became more rapid in the spring, little damage was done by these pests. This species was also a heavy producer of green material.

Of the others, *Vicia villosa*, the hairy vetch, was a failure, as it was practically completely destroyed by the red-legged earth mite in the seedling stage. *Vicia monantha,* an early-flowering and maturing species, was not attacked to any serious extent by the flea and mite, but it has a small leaf and is not a good producer of green material.

All the above mentioned vetches were immune to the attack of the pea weevil.

LATHYRUS SPP.

In this section three species were grown, these being the Tangier pea (*Lathyrus tangitanus*), *Lathyrus annus* and *Lathyrus sativus*. Examination of the seed produced showed that none of the *Lathyrus spp.* were affected by the pea weevil. The following gives the results obtained:—

(a) *Lathyrus annus.*

This species has a much finer type of stem and smaller leaves than the Tangier pea. In the earlier stages of growth, the young plants are attacked by both the red-legged earth mite and lucerne flea, but none of the plants were destroyed. Rapid growth does not commence until September and flowering begins early in November. This species is a very heavy yielder of seed and produces a good bulk of green material.

(b) *Lathyrus tangitanus.* Tangier Pea.

In the seedling stages this species was very severely attacked by red-legged earth mite and, to some extent, by lucerne flea. In a number of instances the young plants were completely destroyed. Those which survived produced a large bulk of green material, the stalks of which were rather coarse.

The Tangier pea is a prolific seed yielder, and one of the principal difficulties with it is the harvesting of the seed economically. Owing to the plants growing in a tangled mass, it is practically impossible to use machines of any kind to facilitate harvesting operations.

(c) *Lathyrus sativus.*

This is a much earlier species than either of the foregoing, as it is in full flower by the middle of October. It, however, is attacked by the red-legged earth mite and the lucerne flea but not as severely as the Tangier pea. The yield of green material and seed is good but not equal to that of the Tangier pea.

GRASSES.

During the past two seasons many additional species and strains of grasses have been grown to test their persistency, productiveness and suitability for non-irrigated conditions. The results to date are as follow:—

Rye Grasses (Lolium spp.).

(a) *Perennial.*

A total of 15 strains obtained during the previous two seasons from Victoria, New Zealand, Great Britain and locally were planted at the Research Station.

During the season 1936 the most outstanding strains were the Certified Victorian Clunes, New Zealand Hawke's Bay Certified Mother Strain, and St. Arnaud strain, which originated from the Clunes strain.

The recovery of all strains was observed after the first general rains early in March, 1937, following one of the driest summers on record for Denmark when the annual rainfall for 1936 was some 12 inches below the average.

The Clunes and St. Arnaud strains gave over 98 per cent. recovery, while other strains gave as low as 12 per cent. During 1937 these two were the most outstanding with the New Zealand Hawke's Bay and Victorian Colac next best.

Rusting of these grasses was severe in one case only. The majority of the strains were only slightly attacked, while the others were free.

All were only slightly attacked by the red-legged earth mite and lucerne flea, with the exception of five lines of Clunes.

(b) *Annual and Biennial Rye Grasses.*

Of the five under test the New Zealand Certified Italian rye grass was the most outstanding, producing an excellent bulk of green material and had a very high proportion of leaf to stem.

Phalaris tuberosa.

Of the seven lines under test, all showed signs of slight attack by the red-legged earth mite and lucerne flea. There was very little variation in the persistency and yield of the Victorian, New South Wales, and South Australian strains. All gave over 95 per cent. recovery after the first season.

Of the other grasses tested, the "Tall Fescue" was the most outstanding, giving very vigorous growth during the winter and spring, and the recovery was excellent in the autumn.

EXPERIMENTS WITH TOBACCO SEED-BED COVERS AT MANJIMUP (1937).

A. SHARP, U.D.A.,
Tobacco Adviser.

The series of experiments initiated by the Department of Agriculture in 1936 with the object of discovering a satisfactory covering material for tobacco seed-beds, and an account of which was given in the issue of this Journal for December, 1936, pp. 503-507 (subsequently being reprinted as Leaflet No. 498), was continued during the 1937 season.

The following types of cover were tried:—

1. (Control). Unbleached calico treated with a mixture of paraffin wax, petroleum jelly, boiled linseed oil and mineral turpentine, as described in the above-mentioned article.
2. Unbleached calico, washed to remove the dressing and treated with boiled linseed oil.
3. Unbleached calico, washed to remove the dressing and treated with raw linseed oil.
4. "Windowlite," a flexible, translucent cellulose material, reinforced with fine mesh wire netting.

NATURE OF THE SEED-BEDS.

The small cold frames formerly used in the Department's seed-bed experiments were discarded in favour of long narrow beds of the usual commercial type. These were made 3 feet wide and 36 feet long, the jarrah frames being 15 inches high at the back and 6 inches high in front. Each bed was fitted with four sashes, each 9 feet long by 3 feet 3 inches wide, and hinged at the back so that the covers could be thrown open in fine weather and closed at night with a minimum of trouble. The covers were tacked on to these sashes, each of the four types of cover being fitted over one quarter of each bed. Three such beds were used in the experiment, thus permitting of each cover being replicated three times in order to lessen the chance of error due to inequality of soil or other cause.

The beds were sown on 4th August, and from then until germination they were watered every second day with slightly warmed water. It was observed that the surface of the soil under the windowlite covers tended to become drier than that under the calico covers.

Fig. 1.—General view of the 1937 Experimental Seed-beds at Manjimup. In the foreground are two tent-type beds. Behind them are the three beds fitted with experimental covers attached to hinged sashes. On the right are beds in which a number of varieties of tobacco seedlings was raised and fertiliser experiments carried out. The hinged covers on the bed on the extreme right bottom corner have been opened, and are being supported in a partially open position on wooden battens for photographic purposes.

—*Photo by Author.*

RELATIVE SPEED OF GROWTH OF SEEDLINGS.

The first signs of germination were observed under the windowlite and linseed oiled covers on 23rd August, 19 days after sowing, and under the "control" covers four days later. From then on, growth under all the covers was quite good, but the plants under the windowlite and calico treated with boiled and raw linseed oil came away rather more rapidly than those under the control (waxed) covers. The seedlings under windowlite especially made excellent progress, and were ready for transplanting at the beginning of October, just two months after the seed was sown. Growth under the two kinds of linseed oiled covers was about equal and only a very little behind that of the plants under windowlite, while growth under the control covers was definitely slower, the plants requiring about a week to ten days longer to reach transplanting size.

Benzol at a concentration of one square inch of evaporating surface to each square foot of seed-bed was introduced into all the beds about three weeks after germination, and no Downy Mildew appeared under any of the covers.

The seedlings were planted out in the Department's field experiment plots at Jardee, and no difference was observed between the seedlings grown under the various covers so far as percentage strike and subsequent growth were concerned.

LONGEVITY OF THE COVERS.

With regard to the covers themselves, the windowlite appeared to be in just as good condition at the end of the season as it was when new, and it would appear that this material, although expensive to instal, costing about 7s. 6d. per square yard, should last quite a number of years with reasonably careful handling, and cost no more in the long run than the less durable calico.

The calico covers treated with linseed oil, both raw and boiled, deteriorated badly, and were quite unfit for further use at the end of the season. It had been suggested to the writer that washing the dressing out of the new calico before

Fig. 2.—Seedlings in one of the experimental beds ready for transplanting.
—*Photo by Author.*

applying the linseed oil would obviate the rotting effect experienced in previous experiments, but this was not found to be the case.

The "control" covers treated with the paraffin wax mixture, while not producing quite such rapid growth of the seedlings, were in other respects quite satisfactory. They kept their appearance well, only a very slight amount of discolouration being evident at the end of the season, and the strength of the calico appeared to be practically unimpaired. These covers were stored away carefully at the end of the season and it is anticipated that they will be fit for use for another season at least.

HINGED SASHES ON SEED-BEDS HIGHLY DESIRABLE.

In addition to the three seed-beds used in this experiment, two beds of a rather simpler type were constructed and covered with waxed calico. These are shown in the foreground of fig. 1. In order to uncover these, the calico, which was tacked along the back of the bed, drawn over a slightly elevated centre rail, and fixed in

position by hooks along the front, had to be rolled up. As a rule it was still wet when rolled up in the morning, and it discoloured very badly as compared with similarly treated covers which were tacked to sashes. It is considered that the extra expense involved in fitting the seed-beds with removable or hinged sashes, to which the covering material is permanently attached, is justified by the saving of time

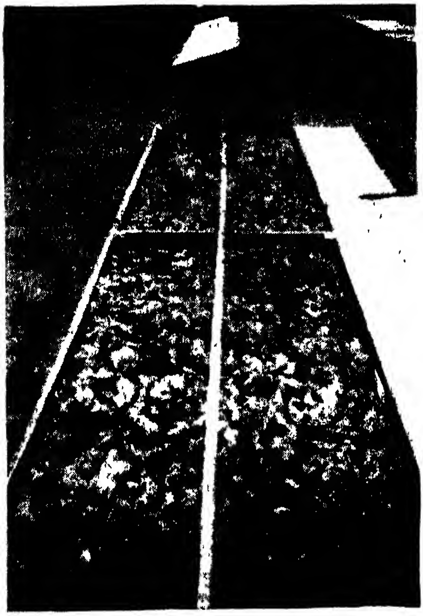


Fig. 3.—A tent-type seed-bed, showing raised centre rail and rolled-up cover alongside. The two rows of tins for holding benzol can be seen spaced at regular intervals along the bed.

—*Photo by Author.*

Fig. 4.—The reward of careful seed-bed management and careful attention to all the necessary techniques in the field subsequent thereto. The ripe leaf strung on the stick and about to be placed in the curing barn.

—*Photo by Author.*

occupied in covering and uncovering the beds and in the better preservation of the covers. As the time required for the benzol treatment of tobacco seed-beds each day, if the seed-beds are at all extensive, is already, in the aggregate, very considerable, the adoption of any time-saving devices, the cost of which is not prohibitive, is very well worth while.

DAIRY CATTLE IMPROVEMENT ACT AND AMENDMENT ACT.

The Department wishes to warn all owners of bulls who have failed to comply with the regulations under the above Act and take out registrations due for 1938, that action to enforce the provisions of the Act is now being taken. All farmers are therefore advised that it is essential for registrations to be finalised immediately.

THE NEW FRUITFLY REGULATIONS.

G. W. WICKENS,
Superintendent of Horticulture.

The attention of all fruitgrowers throughout the State is drawn to the new fruitfly regulations given below, which were gazetted on the 20th May, 1938, in response to a request received by the Hon. Minister for Agriculture from the Fruitfly Advisory Board.

Two portions of the State, namely, those comprised in the Swan Road Board area and the Darling Road Board area, have been gazetted as infested places, and all owners or occupiers of orchards and/or vineyards in those areas must regularly, at stated periods, apply sodium fluosilicate bait to the trees and vines whether fruitfly is present or not.

The areas in the State outside those comprised in the road boards mentioned must apply sodium fluosilicate baits at stated periods commencing immediately fruitfly is discovered in the orchard and/or vineyard.

THE SCHEDULE.

The regulations made under and for the purposes of the Plant Diseases Act, 1914-1935, as published in the *Government Gazette* on the 16th day of September, 1921, are hereby amended by inserting therein after Division V. a new division, to stand as Division VA., as follows:—

Division VA.

Fruit Fly.

46A. The disease called Fruit Fly (*Ceratitis capitata*) shall be and is hereby declared to be a disease to which the provisions of section 8A of the Plant Diseases Act, 1914-1935, shall apply.

46B. For the purpose of controlling and eradicating the said disease and for preventing the spread thereof, the due observance of the provisions in this regulation hereinafter contained shall be appropriate steps and measures within the meaning and for the purposes of section 8A and section 8B of the said Act to be taken and adopted by owners and occupiers of orchards to which the said sections relate, that is to say:—

(A) In every orchard containing one or more fruit trees or one or more fruit vines, when either under section 8A or under section 8B of the said Act the owner or occupier of such orchard is required to take appropriate steps and measures for controlling and eradicating or for preventing the spread of the disease called Fruit Fly (*Ceratitis capitata*), such owner or occupier shall do or cause to be done the following things, namely:—

(i) gather all fallen fruit from the ground as follows:—

(a) Loquats, apricots, peaches, nectarines, plums, figs, pears, guavas, persimmons and quinces—once at least in every 24 hours.

(b) Apples, citrus fruits and other fruits not mentioned in the next preceding subparagraph—once at least in every three days;

(ii) destroy by boiling or by some other method approved by an inspector all fruit gathered from the ground as aforesaid and found to be infested with the said disease;

(iii) apply to every fruit tree and to every fruit vine in the orchard having fruit thereon by means of a hand syringe or a spray pump, or by some other method approved by an inspector, fruit fly bait made in accordance with the formula hereinafter prescribed or in accordance with some other formula as hereinafter mentioned and provided for, and which shall be so applied according to the following directions, namely:—

(a) at least one gallon of the fruit fly bait shall be used to every forty fruit trees or to every one hundred fruit vines required to be treated, and so that each fruit tree or each fruit vine is thoroughly sprayed or treated;

(b) the first application of the fruit fly bait shall be made when the fruits on the trees or on the vines (as the case may be) are within six weeks of ripening;

(c) after such first application aforesaid further applications shall be made at least once in every six days during the whole of the ripening period; and until the expiration of two weeks after all the ripe fruits shall have been removed or fallen from the said fruit trees or the said fruit vines.

(B) The formula for making fruit fly bait as provided for in and for the purposes of paragraph (A) of this regulation shall be as follows:—

Sodium fluosilicate .. .	1 ounce.
Sugar	2½ lbs.
Water	4 gallons.

Provided that, in lieu of the said formula, any other formula may be used of which the Minister approves as notified in the *Government Gazette* whilst such notification remains unrevoked by a subsequent notification in the *Government Gazette*.

Plant Diseases Act, 1914-1935.

Department of Agriculture,
Perth, 12th May, 1938.

I, THE undersigned, Minister for Agriculture, being the Minister charged with the administration of the Plant Diseases Act, 1914-1935, acting in exercise of the power in this behalf conferred upon me by section 8B of the said Act and for the purposes of subsection (2) thereof do hereby declare that those portions of the State which are comprised within the boundaries of the Swan Road District and the Darling Range Road District as now constituted under the provisions of the Road Districts Act, 1919-1934, respectively, are each and both of them infested with the disease called Fruit Fly (*Ceratitis capitata*) which is a disease to which sections 8A and section 8B of the said Act, and the regulations made under the said Act, apply.

(Sgd.) F. J. S. WISE,
Minister for Agriculture.

Approved by His Excellency the Lieutenant-Governor in Executive Council this 12th day of May, 1938.

(Sgd.) L. E. SHAPCOTT,
Clerk of the Council.

THE TUNG-OIL TREE.

(*Aleurites Fordii* Hemsl.)

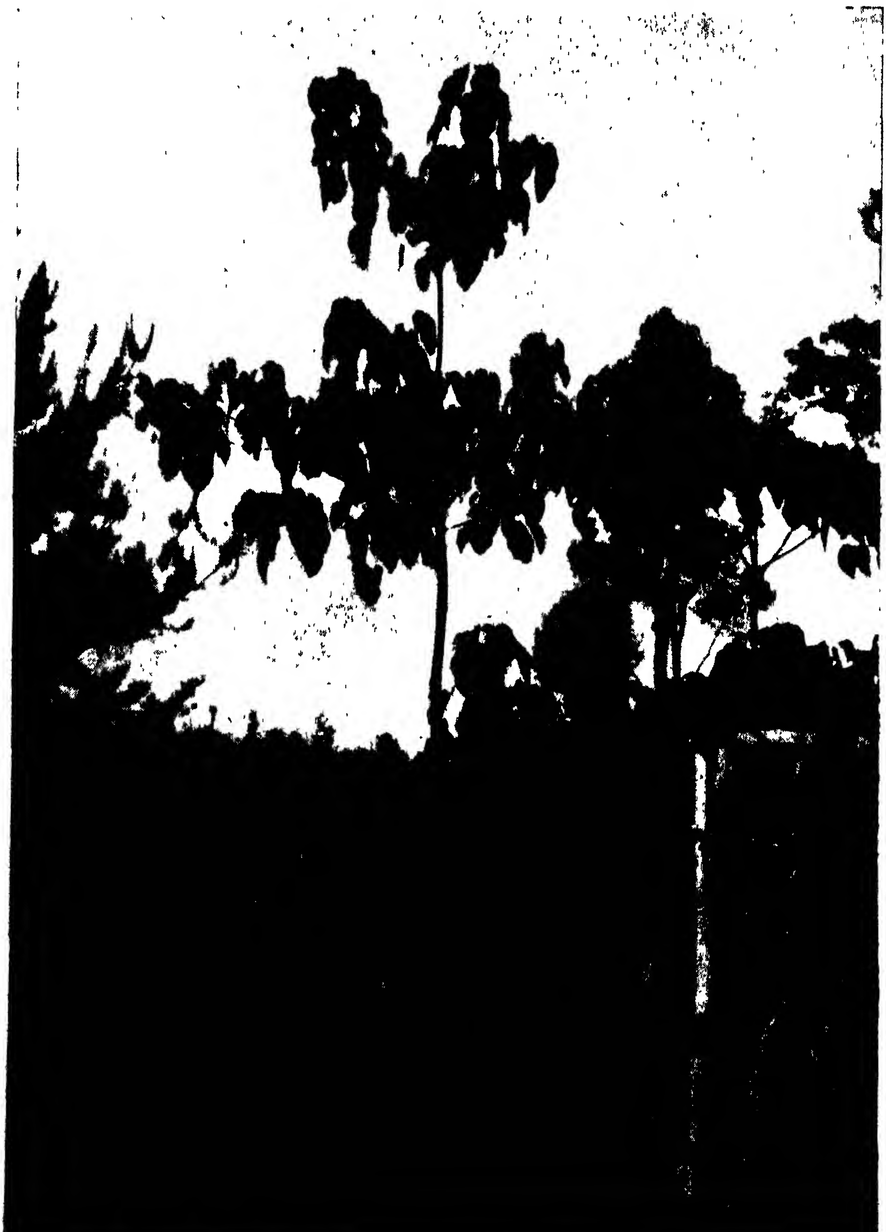
G. R. W. MEADLY,
Acting Government Botanist.

Much has been said and written in this State recently concerning the Tung-oil tree, and this short article has been prepared following inquiries from many sources.

The Chinese wood-oil or Tung-oil tree, native to Central and Western China, is now cultivated commercially in other countries, especially the United States of America. It is a deciduous tree which attains a height of 25 feet and produces a fruit two to three inches in diameter, somewhat like a small orange in shape. Each fruit contains three to seven firm, brown-coated seeds from which the oil is extracted. In China this oil has many incidental uses, such as for lamp oil and medicinal purposes. Its main commercial uses, however, are in the manufacture of waterproof varnishes, paints, etc., rubber substitutes, linoleum and insulating compounds. The United States imports about 13,000,000 gallons annually, whilst the consumption in Australia, although at present only about 150,000 gallons, is steadily increasing.

As the Chinese apparently have not attempted to cope with the increased demand by preparing extensive plantations to supplement the natural supply, other countries are investigating the possibility of producing their own requirements.

In 1931 one thousand seeds of the Tung-oil tree were obtained from the Royal Botanic Gardens, Kew, for trial purposes. These were distributed to various parts



Tree, four years old, growing at Byford.
[*Photo by courtesy of the "Sunday Times" newspaper.*]

of the State including Hamel, Bridgetown, Salmon Gums, Bencubbin, Broome and Perth. A fair germination was secured at Broome, but the young plants were dried considerably by the hot winds. The Forests Nursery at Hamel raised 126

plants, but apart from this no encouraging reports were received. These plants were distributed to various places in the South-West, but the results secured cannot be considered satisfactory. Many failures, however, were certainly due to lack of attention. A number of trees raised from seed planted four years ago at Byford are now bearing and provide the most encouraging results achieved with the Tung-oil tree in this State.

Three trees which were not transplanted from the original nursery site are now approximately twenty feet high. Last year they yielded a few pounds of seed each, and this season, although the crop has not yet been gathered entirely, they are expected to average about 10 pounds of fruit per tree. The trees which were transplanted are not so far advanced and, in the main, have not received the attention given to the three larger trees.

Most of the Tung-oil trees growing in this State were planted in August of last year on a variety of soils. A number of failures have been tempered by some quite encouraging results, but all the orchards are young and still essentially in

Fruiting branch on the tree illustrated.
[*Photo by courtesy of the "Sunday Times" newspaper.*]

the experimental stage. Until they are four or more years old, when some idea of the yield of fruits may be ascertained, no decision of very significant value can be made concerning the future of the industry in this State. A condition evident in all orchards visited is a lack of uniformity in growth. Some trees after nearly twelve months are over two feet in height, while others have produced shoots only a few inches long on the original stocks. In some cases the cause is obviously poor drainage, but in others the reason is not so evident and frequently appears to depend upon the condition of the individual trees when planted. Healthy trees were noted on different soil types, including sand containing very little loam, a rich loam and a very gravelly loam. In no cases where poor drainage was evident were satisfactory results secured, and some orchards were irrigated during the summer months. Available summer moisture will probably constitute the limiting factor associated with Tung-oil production in this State.

As local experience does not allow us to advise regarding cultural methods, etc., the following information has been compiled mainly from Bulletin No. 12 (3rd edition) prepared by A. R. Penfold and F. R. Morrison and issued by the Technological Museum, Sydney.

PLANTING.

The seeds germinate in Australia about late September and October, and therefore the correct time to sow the seed is in the early spring. Improved results have been secured by soaking the seeds for a period of 36-48 hours prior to planting. The best practice is to purchase seed only in the husk and to dehusk just prior to soaking in water.

THE NURSERY.

The nursery site should be a sunny, well-drained portion of the garden or plantation area, and the ground worked into a fine tilth. Sowing in rows three feet apart is recommended, spacing the seeds about eight inches and covering with about 1½ inches of soil. Germination usually occurs between thirty and sixty days after sowing according to locality and prevailing climatic conditions, but some seed has germinated after remaining in the ground for more than twelve months.

Care should be taken when the seedling first emerges from the seed-case to maintain the soil around the young plant in a loose and friable condition. The application of a well-balanced fertiliser, especially well-rotted manure, will hasten the growth of the young plants. After about nine months, in the dormant season when the leaves have been shed, the plants should be ready for lifting and setting out. As the plants at this stage are normally 12-18 inches in height and have a root system about twelve inches long, care must be taken to retain as much of the root soil as possible and thus avoid destruction of the feeding root hairs.

THE ORCHARD.

The planting of seeds in the actual position where the trees are to remain is recommended, although many growers prefer to use the plants grown in the nursery. Practically any soil, provided it is well drained and contains sufficient available moisture in the summer, is suitable, but the ideal appears to be a slightly acid sandy loam or loam underlaid with clay at a depth of 3-5 feet. The plantation area should be ploughed and cultivated to a fine tilth.

As a general rule Tung trees can be expected to grow in areas where citrus culture is conducted successfully, but regions subject to erratic and unseasonable frosts and low rainfall should be avoided.

Australian experience has led to the conclusion that an initial planting of 160-200 trees per acre is desirable. This number permits the weeding out of weak plants during the first three or four years without disturbing or checking the growth of the remaining trees. For profitable results fully 150 vigorous trees, well formed and good bearers of fruit, are necessary by the fifth or sixth year.

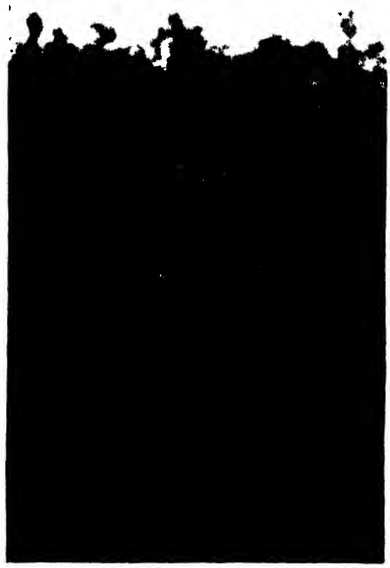
The plantation should be cultivated to maintain a clean floor, which is best done by shallow discing during the growing period. Freedom from all rubbish immediately around the trees is most desirable, as borer trouble may develop if the quick growing tree is wounded by the action of hoes or other appliances. In accordance with American experience, it is recommended that the orchardist makes full use of the alleys between the trees for the production of suitable annual crops for green-manure purposes.

Fertilisers should be chiefly nitrogenous, farmyard manure being preferable, and care should be taken when applying artificial manures. If the site of the

orchard is virgin land, the problem of artificial manures will not be a pressing one until the trees commence to bear. Applications of a few ounces to one pound of a complete fertiliser adjacent to each tree will then hasten growth and increase the leaf surface.

The tree is a fast grower, normally producing some fruits when three years old. A good crop of fruit yielding oil of satisfactory quality, however, is not secured before the fourth or sometimes the fifth year.

The grazing of stock in Tung orchards is not advised owing to the danger of limbs being broken by cattle rubbing against them. Animals can do appreciable damage in this manner, and goats have also shown a predilection for the foliage of the trees.



Young tree seven months old after transplanting from the nursery.
[*Photo by courtesy of the "West Australian" newspaper.*]

DISEASES AND INSECT PESTS.

The Tung-oil tree is relatively immune from attack by disease and insect pests, only a few instances of minor importance having been recorded in Australia. As the cultivation of this tree extends, however, more difficulties of this nature must be anticipated.

YIELD.

Naturally the yield of fruit is very variable, but Penfold and Morrison consider that a tree to be of commercial value for oil purposes should yield a minimum of 1,000 fruits per annum. To predict the yield of oil likely to be obtained under local conditions is extremely difficult, but a conservative estimate upon which to base the probable return from a fair average commercial grove is about half a gallon of oil per tree from the sixth to the tenth year.

ALL AUSTRALIAN PORKER AND BACONER CARCASES COMPETITION.

G. K. BARON-HAY,
Superintendent of Dairying.

During 1937 the Australian Meat Board organised competitions for classes of porker and baconer carcases suitable for export, with the view of encouraging the breeding and management of pigs so as to produce a type of carcase suitable for the English market.

The results from the first competition are now to hand, the judging having been carried out by Mr. H. R. Davidson of the School of Agriculture, Cambridge, and Mr. Jos. B. Swain of Empire Pork House, London.

The judging was carried out in accordance with the standards laid down by the above two judges and Dr. John Hammond of the School of Agriculture, Cambridge, so as to comply with the requirements of the British bacon and pork market.

Baconer Carcases Competition.

Thirteen entries in this class were received from the various States, one only being from Western Australia, which was submitted by Mr. W. G. Burges, Burges' Siding.

Table 1 shows the total marks which were awarded to each of the entries in this class.

TABLE 1.

ALL AUSTRALIAN BACONER CARCASE COMPETITION—SMITHFIELD, LONDON, DECEMBER, 1937.

Analysis of Results for Individuals on a Percentage Basis.

—	Individual Competitors Results.	Principal Feeds, etc.	Breeds.	Marks Awarded.	Percentage.
					%
South Australia	Inspector General of Hospitals (entry No. 6)	Crushed barley, crushed wheat, crushed peas, skim milk	Large White	280	74·6
Victoria	W. Logie (entry No. 2)	Barley and boiled potatoes	Large White x Large White x Middle White	269	71 7
Queensland	Kingston Farm Pig Co. (entry No. 2)	Buttermilk, maize, pollard, oatmeal. Paddock reared, finished last 6 weeks in pens	Large White	261	69·6
South Australia	J. W. Aldridge (entry No 2)	Peas, barley and meat meal	Large White	258	68·8
South Australia	Inspector General of Hospitals (entry No. 5)	Crushed barley, crushed wheat, crushed peas, skim milk	Large White x Berkshire	257	68·5
South Australia	W. H. E. Crosby (entry No. 3)	Mixed corn, skim milk, pollard; free range	Large White x Tamworth x Berkshire	250	66·6
Victoria	H. C. Nankivell (entry No. 1)	Pasture skim milk, boiled potatoes, finished with barley, peas and skim milk	Large White	249	66·4
Victoria	F. Hawtin (entry No. 1)	Milk, pollard, crushed barley, yard feed	Large White	246	65·6
South Australia	J. W. Aldridge (entry No. 4)	Peas, barley and meat meal	Large White x Berkshire	246	65·6
Victoria	Nestle Anglo Swiss Milk Co. (entry No. 1)	Buttermilk, whey and crushed barley: indoors from time of birth	Tamworth x Berkshire	240	64 0
South Australia	J. H. Dawkins (entry No. 1)	Crushed barley and meat meal	Large White x Middle White x Large White	225	60·0
Western Australia	W. G. Burges (entry No. 1)	Wheat, Meat, Meal	Canadian Berkshire	218	58·1
Queensland	Kingston Farm Pig Co. (entry No. 1) (Not in competition—2 carcases only)	Buttermilk, maize, pollard, oatmeal: paddock reared; finished last 6 weeks in pen	Large White	172	68·8

The winning exhibit submitted by the Inspector General of Hospitals in South Australia is shown in Illustration 1, the detailed points for which are as follow. (See Table 2.)

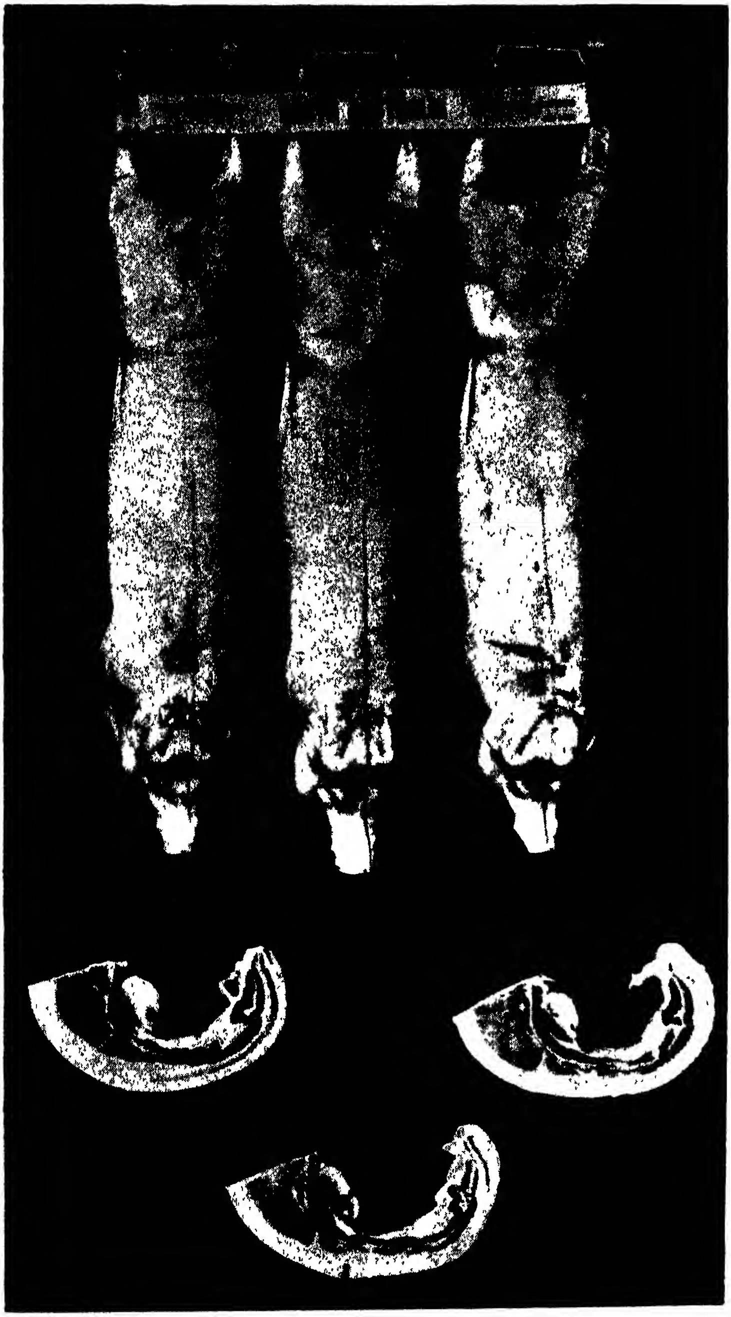


Illustration 1.—Winning baconer entry, exhibited by Inspector General of Hospitals, South Australia.

TABLE 2.

AUSTRALIAN MEAT BOARD PIG COMPETITION, DECEMBER, 1937.
Judges: H. R. DAVIDSON and JOS. B. SWAIN.

Winning Exhibit Baconer Class.

Breed—Large White. Inspector General of Hospitals. Entry No. 6.

——	Maximum Marks.	Actual	Marks.	Ideal.	Actual.	Marks.	Ideal.	Actual.	Marks.	Ideal.	Percentage.
A.—Inspection											
Skin } Colour }	5		5			5			5		100
Dressing	5		5			5			5		100
Hams	8		5			4			6	....	62·5
Shoulders	7		4			5			4		61·9
Streak	12		7			7			7		58·3
B.—By Measurement											
Eye Muscle	28	46	20	54	44	19	53	47	21	54	71·4
Fat Thickness	20	22	18	20	16	17	19	17	17	20	86·6
Body Length	20	745	8	805	770	15	795	780	13	815	60
Leg Length	5	580	2	559	585	1	554	560	5	564	53·3
Wgt Suitability	15		15			15			15		100
Total ...	..		89			93			98		
Total (3 carcases)						280			.		74·6

In commenting on the exhibits in the baconer class, the judges stated that the carcases which were submitted for the competition were generally superior to the commercial product, which has not always been the case in other competitions and indicates the great interest, care and attention given by competitors in the preparation of their pigs.

The importance of having 3 carcases in each entry is corroborated by several exhibits. Not only does this give a better average for marking purposes, but reduces the inevitable risk when pigs which are to be judged on carcase points only must be selected alive.

In one exhibit from South Australia where the carcase weighed 160 lbs., it was undoubtedly the leanest looking carcase of the three in that entry when judged on external conformation but proved to be the fattest when cut through the loin. This relationship has been noticed by the judges on other occasions and proves not only the importance of carcase tests in addition to live weight inspection but also the necessity of having a fair sample to judge.

While the results have been analysed on a breed basis, the judges feel that too much attention should not be placed on this, owing to the small numbers of pigs which have been inspected. A standard product is what is required by the Smithfield Market, and, as there are of necessity considerable variations in management and environment, it may be necessary to use different types within the breed to arrive at the standard carcase. This is in accord with Departmental advice which has been to restrict the number of breeds as far as possible and to rely on selection within the breed for improving the standard of carcase.

The following comments on the different points which have been judged are of interest:—

Skin and Colour.—5 marks.

It is necessary for successful marketing that the carcase should retain its natural bloom and be free of bruise marks, scratches, bites, etc. Even in this com-

petition where it would be expected that pigs had been treated with special care, entries were submitted which were bruise marked and blotchy in appearance.

Dressing.—5 marks.

All entries scored 100 per cent. of marks so that this point calls for no comment. This should be gratifying to exhibitors and indicates that, provided the right type of carcase is submitted to the abattoirs, the treatment there can be carried out in a satisfactory manner.

Hams.—8 marks.

The average marks for all entries was 72.3 per cent. of the possible total and indicates that the hams were very good.

The variation in the breed analysis was from 62.5 per cent. to 87.5 per cent. and follows breed characteristics fairly closely.

It will be noted in Table 3 that pigs containing "Berkshire" blood have scored highly for hams, while the "Large White" crosses were generally weak in type of ham. In each case, however, these breeds have other compensating factors.

Shoulders.—7 marks.

With an average of 68 per cent. marks, the type of shoulders was not quite so good as the hams. The exhibit of Canadian Berkshires from Western Australia was surprisingly low in points for this section. Generally, it is to be expected that, where hams are good, shoulders will not be quite so good, and *vice versa*

In the illustration of this, it will be seen that the "Large White" breed has the lowest marks for hams and the highest for shoulders, and that the Canadian Berkshire exhibit has the highest marks for hams and the lowest for shoulders. This is an indication that in every breed careful selection is necessary in order to develop a high quality standard carcase.

Streaks.—12 marks.

This point should be regarded as very good and potentially better than is shown by the average score of 60 per cent. marks.

Points were lost mostly because the "streak" was not thick enough rather than that there was an insufficient amount of lean through the meat. Had there been a little more fat between the muscles, many of the "streaks" would have earned full marks.

Eye Muscle of Loin.—28 marks.

The standard set for this point is a severe one, as it is most important to encourage its development. The average marks of 59.3 per cent. should accordingly be considered a good result.

The average of the "Large White" exhibits was comparatively good, although in other entries individual carcases scored well, the average being reduced by other lower scores. This again stresses the importance of selection for type within the breed.

Back Fat Thickness.—20 marks.

The results under this heading are very good and even better than suggested by the average of 66.1 per cent. of possible marks.

It is interesting to note that an exhibit by Mr. W. Logie of Victoria, whose exhibit was second in the competition, scored 96.6 per cent. for thickness of back

fat, which the judges remarked was the best score that has yet been recorded under this system from any pen of three pigs.

The entries, generally, lost marks through too great a thickness of back fat.

Body Length.—20 marks.

It is in respect of this point, on which the average marks of all entries only reach 45.6 per cent. of the possible, that the entries as a whole are deficient. There is, however, great variation, the difference between the best and the worst being 59.7 per cent.

Even within one breed—the "Large White"—there is a variation of from 48.3 per cent. to 75 per cent., while in this particular section the exhibit of Canadian Berkshires only scored 13.3 per cent. of the marks for body length—a character in which this breed usually excels.

Leg Length.—5 marks.

The average marks of 72.6 per cent. are very good indeed, particularly considering the preponderance of "Large White" influence which generally scores low in this section.

"Berkshire" and "Middle White" entries were particularly good in this section, especially the "Berkshire."

Suitability of Carcase Weight.—15 marks.

Loss of marks in this section is entirely under the control of exhibitors, as the optimum marks for the most suitable bacon market weights, namely, 135 to 154 lbs., should be well known.

TABLE 3

Analysis of Breeds

——	Maximum Marks.	Large White. 6 entries	Large White x Berkshire. 2 entries.	Large White x (Tamworth x Berkshire). 1 entry.	Large White x (Middle White x Large White). 2 entries.	Tamworth x Berkshire. 1 entry.	Canadian Berkshire x Berkshire 1 entry.
A.—By Inspection		%	%	%	%	%	%
Hams	8	66·1	68·7	87·5	77·0	79·1	81·6
Shoulders	7	72·2	69·0	66·6	69·0	61·9	47·6
Streaks	12	66·6	51·8	50·0	48·5	72·2	61·1
B.—By Measurement							
Eye muscle of loin	28	60·9	61·9	51·1	64·9	51·7	51·1
Back fat thickness	20	63·5	63·3	65·0	76·6	66·6	66·6
Body length	20	62·0	50·8	46·6	20·0	26·6	13·3
Leg length	5	56·4	83·3	100·0	80·0	73·3	100·0
Average	100	63·2	60·8	59·3	58·3	56·0	52·6

Porker Carcases Competition.

In the porker carcases competition nine entries were received, no entries being forwarded from Western Australia.

The winning exhibit was forwarded by A. H. Callaghan, Principal, Roseworthy Agricultural College, a reproduction of which is shown in Illustration 2, and the detailed marks for which are shown in Table 4.

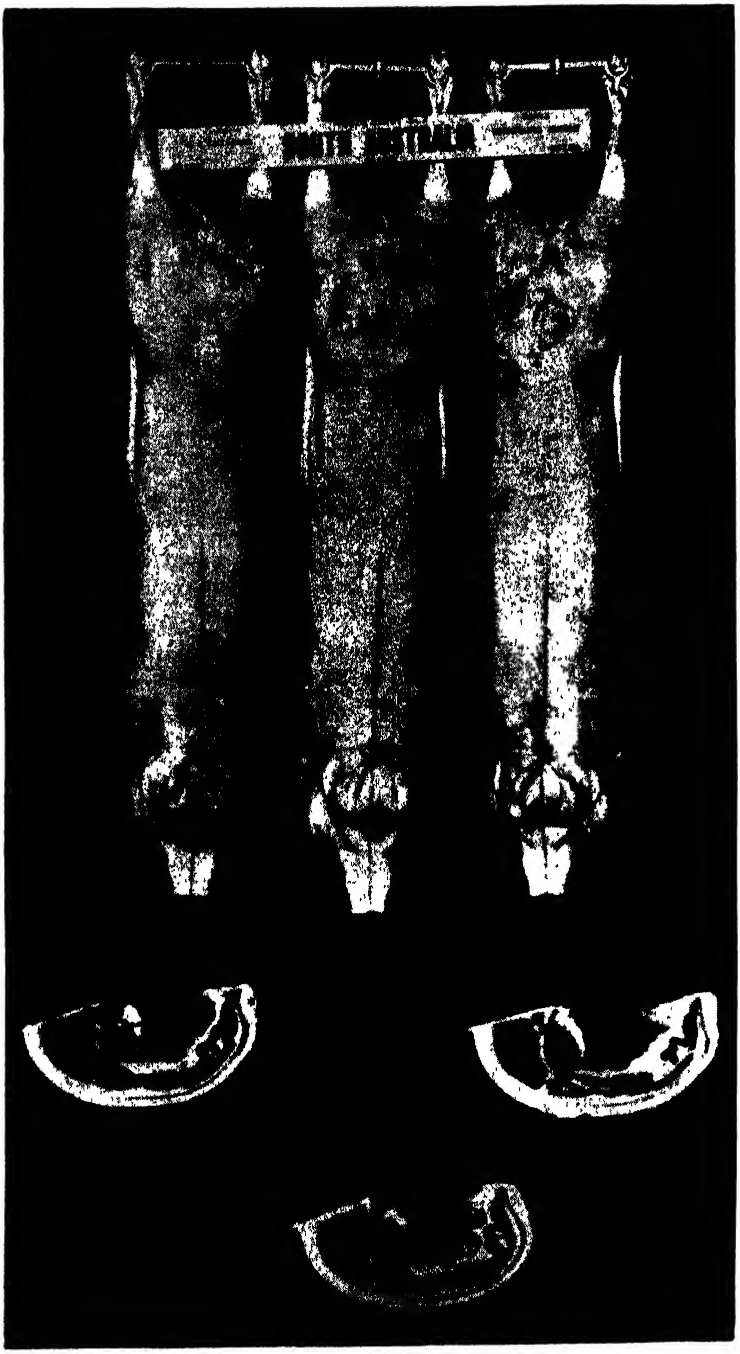


Illustration 2.—Winning porker entry, exhibited by A. H. Callaghan, Principal Roseworthy Agricultural College, South Australia.

TABLE 4.

AUSTRALIAN MEAT BOARD PIG COMPETITION, DECEMBER, 1937.
Judges: H. R. DAVIDSON and JOS. B. SWAIN.

Winning Exhibit Porker Class.

Breed—Can. Berk. x Large White. A. H. Callaghan. Entry No. 3.

——	Maximum Marks.	Actual.	Marks.	Ideal.	Actual.	Marks.	Ideal.	Actual.	Marks.	Ideal.	Percentage.
A.—Inspection											
Skin	5		4			4			4	..	80
Colour	5		4			4			4		80
Dressing	5		5			5			5		100
Hams	8		6			5			5		66·6
Shoulders	7		5			5			5		71·4
Streak	12		9			9			6		66·6
B.—By Measurement											
Eye Muscle	28	42	20	50	42	21	50	43	21	50	73·8
Fat Thickness	20	14	18	12	13	19	11	15	16	12	88·3
Body Length	20	655	10	705	662	13	695	660	11	705	56 6
Leg Length	5	485	4	479	485	8	469	475	5	479	80
Total			85			88			82		
Total (3 carcases)						255					73 9

It is interesting to note that the Inspector General of Hospitals in South Australia forwarded the exhibit gaining second place in the porker class and whose exhibit in the baconer class occupied the winning position.

In connection with this competition, the judges report that this was carried out in accordance with the standard laid down as for baconer classes, and includes marks for skin, colour and dressing.

Skin and Colour.

The results of 89.5 per cent. and 87.6 per cent. respectively are very good, losses being accounted for by slight bruises, scratches, and bites.

Owing to inclement weather, photographs had to be taken by flashlight, which may give misleading results owing to shadow.

Dressing.

All States scored 100 per cent. except New South Wales where one mark from each carcase was deducted because the fore feet were incorrectly tied up, which tends to throw the shoulders out of shape and may cause low marks for shoulders.

Hams, with a result of 67.8 per cent., were quite up to standard and would have been better but for the poor result of 50 per cent. in one State.

Shoulders showed a considerable variation, the average of 62.3 per cent. being quite good, but one State with only 38 per cent. was well below normal.

Streaks.

An average marking of 59.1 per cent. is possibly better than it appears, as there was not sufficient fat between the meat. Apparently competitors endeavoured to obtain too lean a carcase with a loss of marbling fat.

Eye Muscle of Loin.

The result of 65.9 per cent. is good, although there is very wide difference in many of the carcases.

Back Fat.

The average marks of 74 per cent., which would have been better but for the low marks in one State, are very good and indicate that the Australian farmer realises that the British public requires lean meat.

Body Length.

Body length as in the case of the baconer exhibits was not good, although the average of 50 per cent. is reduced by the Queensland entries which gained only 31.6 per cent. It is interesting to note that these entries were of crossbred "Middle Whites."

Leg Length.

Leg length with an average of 61.9 per cent. was good and was reduced by the Victorian entry with only 40 per cent.

General Remarks.

The pigs were of good marketable quality, and a study of the individual reports and the analyses perhaps will give the clearest indication of the results which at 66.9 per cent. for the whole competition are good.

Owing to the wide variation of breeds and crossbreds, a detailed analyses of the results would be unjustified. It is felt, however, that the consistently low marks for "body length" where the "Middle White" is used in crossing cannot be ignored.

Tables Nos. 5 and 6 below give details of the exhibits from each State and the average marks obtained in each section.

TABLE 5.

ALL AUSTRALIAN PORKER CARCASE COMPETITION—SMITHFIELD, LONDON, DECEMBER, 1937.

Analysis of Results of Individual competitors.

Competitors Results.	Principal Feeds and Husbandry.	Breeds.	Marks Awarded.	Percentage.
South Australia— A. Callaghan (entry No. 3)	Mixture of barley wheat and peas, mainly outside feeding	Canadian Berkshire x Large White	255	73·9
South Australia— Inspector General of Hospitals (entry No. 4)	Crushed barley, crushed wheat, crushed peas, skim milk	Large White x Berkshire	244	70·7
New South Wales— Australian Chilling & Freezing Co. (entry No. 1)	Wheat, butter-milk, limewater, offal and greenfeed	Large White x Tamworth	227	65·7
South Australia— E. A. Farr (entry No. 5)	Skim milk and crushed barley	Large White x Large White x Berkshire	225	65·2
Victoria— W. Logie (entry No. 1)	Barley and boiled potatoes	Large White x Large White x Middle White	210	60·8
Queensland— Wallace & Son (entry No. 1) (1 pig only 80 lbs.)	Kitchen refuse with meat meal and maize meal	Tamworth x Middle White	81	70·4
Wallace & Son (entry No. 2) (1 pig only 72 lbs.)	Kitchen refuse with meat meal and maize meal	Middle White x Tamworth	79	68 6
G. W. Winch (entry No. 3) (2 pigs 64 and 66 lbs.)	Table scraps, red comb, pig meal, Borthwicks mebo, no milk: housing intensive system	Middle White x Berkshire	137	59·5
G. W. Winch (entry No. 4) (2 pigs 79 and 85 lbs.)	Table scraps, red comb, pig meal: no milk	Middle White x Tamworth	160	69·5

TABLE 6.

ALL AUSTRALIAN PORKER CARCASE COMPETITION—SMITHFIELD, LONDON, DECEMBER, 1937.

Report and Analysis of Results of States

——	Maximum Marks	New South Wales.	Victoria.	Queensland	South Australia.	Average for All States.
A.—By Inspection		%	%	%	%	%
Skin .	5	93·3	100	86 6	86·6	89·5
Colour	5	100	86 6	86·6	84·4	87·6
Dressing	5	80	100	100	100	97·1
Hams	8	62 5	50	77	69 4	67 8
Shoulders	7	38	80 9	61 9	66·6	63·2
Streaks	12	61 1	52·7	61 1	59 2	59·1
B.—By Measurement						
Eye muscle of loin .	28	61·9	58 3	72 6	65·4	65·9
Back fat thickness	20	80	56 6	72 5	78·8	74
Body length	20	51·6	50	31 6	61·6	50
Leg length	5	66·6	40	70	62·2	61·9
Total .	115					
Total all in average for each State		65 5	60 8	66 2	69 9	
Total all in average all States .						66·9

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No. 535.—*Dairy Premises.* G. K. Baron-Hay.
No. 536.—*Bordeaux Mixture for Home Gardens.* H. A. J. Pittman.
No. 537.—*An Investigation into the Composition of Western Australian Wheatbelt Pastures and Stubbles.* E. J. Underwood, F. L. Shier, and R. J. Harvey.

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***The Management of Poultry under Western Australian Conditions,* by W. T. Richardson, Poultry Adviser.**

This is a most useful and valuable book, not only for beginners, but to all those who keep fowls for pleasure and profit. It deals fully with all matters connected with the industry, including Breeding, Feeding (for stock birds or egg production), Incubating, Brooding and Care of Chicks, Marketing (eggs and poultry), and all matters of use to the poultry-keeper. It also fully describes symptoms of various ailments and diseases and simple treatment for same, and, as the book was written to suit *local conditions*, every poultry-keeper should have a copy by him. Price, 2s.

***The Pruning of Fruit Trees,* by J. F. Moody, Fruit Industries Commissioner:**
This publication contains numerous illustrations, being reproduction of photographs taken in this State, of pruned and unpruned trees, which make the details set out in the letterpress particularly easy to understand. Price 2s. 6d.

***Fruit Packing and the Marketing and Exporting of Fruit,* by J. F. Moody, Fruit Industries Commissioner, and J. Ramage, Packing Instructor.**
This publication contains invaluable information on packing and grading fruit for local and export markets. It is freely illustrated, and no fruit-packing shed should be without a copy. Price 1s. 6d.

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MEADOW HAY.

H. G. ELLIOTT,

Agricultural Adviser (Dairy Branch).

In the spring a task of major importance lies in using to the best advantage the surplus growth which is obtained from our pastures, and utmost attention should be given to the conservation of hay and/or silage to tide over the long summer drought and early winter periods when grass growth is limited.

If surplus spring growth is not properly managed and very little of it conserved, the whole of the feed available from the pastures will show a serious decline in quality and value. Silage and meadow hay are two excellent forms of conserving this surplus growth. It can be said that the amount of silage and hay usually made from the surplus growth from the pastures is less than could be fed, with economic results, to the stock carried; very often this position may be justified by circumstances but more frequently it cannot be justified especially on dairy farms.

In this State meadow hay can be made and stacked relatively cheaply providing modern methods are utilised, while silage can be stored in pits, stacks, or silos at a very small cost per ton. It must be remembered, however, that a good reserve of both hay and silage is an insurance against bad seasons and enables the farmer to increase the stock carrying capacity of his farm.

The following table shows that there has been only a very gradual increase in quantities of hay conserved per cow while the amount of silage conserved per cow has slightly decreased. These figures were obtained from the Better Dairying Competition which was conducted by this Department during the seasons 1931-32 to 1935-36.

—	Reserve per Cow.									
	Hay.					Silage				
	1935–36.	1934–35.	1933–34.	1932–33.	1931–32.	1935–36	1934–35.	1933 34.	1932 33	1931–32.
	tons.	tons.	tons.	tons.	tons	tons.	tons.	tons	tons	tons
1.—Average all zones in wet districts	1·30	1·43	1·49	1·21	1 06	0·55	0·84	0 89	1 16	0 74
2.—Average Zone 6 (Narrogin)	6·03	4·45	4·9	2·9	..		3·25	2 8	3 3	

1.—Receive 30in. to 60in. in Rainfall. 2.—Receive 17in. to 25in. in Rainfall.

Making Meadow Hay.

The value of meadow hay as a fodder for use, especially during the winter months, is gradually becoming a recognised fact for successful farming, and many farmers throughout the State are making a regular practice of keeping a portion of their pastures for this purpose.

Ryegrass and Subterranean Clover being cut with a Special Divider.
[*Block by courtesy of J. Leith Gillespie.*]

Clover hay making often appears simple, but skill is required to obtain the best product, particularly when the weather conditions are uncertain. The aim of every farmer should be to obtain the maximum quantity of material rich in digestible nutrients.

Time to Cut.

The correct time to cut a clover pasture is when the bulk of the plants are coming into flower. Do not wait until full flowering, otherwise some of the valuable constituents of the product will be lost.

This is shown clearly in the following table. 100 lbs. of dry matter contains:—

	Digestible Crude Protein.	Production Starch Equivalent.	Phosphoric Acid.
	%	%	ozs.
Young Pasture, 3in. to 5in. high ...	19	68	22·4
Hay stage Pasture (flowering) ...	10·8	44	9·6
Mature stage Pasture (dry)	4·5	30	6·4

From the above it will be seen that young clover is by far the best, but if cut too early the leaves are tender and the majority of them would be lost during the curing and carting operations, and apart from this, sufficient bulk would not be obtainable for hay. The right time to cut is when the bulk of the plants in the pasture are in the flowering stage. If cut later a rapid decrease takes place in the valuable food constituents and the hay is stemmy, relatively indigestible and some-

what unpalatable. It also must be remembered that late cutting weakens the root stocks of young perennial plants and prevents annual plants from making an aftermath of good grazing value.

CUTTING AND HANDLING.

A good mower with sharp knives, dividers, and a good swathing attachment is essential.

Leave each swath for a day or two to allow the exposed surface to dry sufficiently, after which it should be turned and left for a day to allow the other side to dry. After this operation the swathes are carefully put into windrows and then carted into the stack, avoiding, if possible, cocking. Careful handling is essential to prevent damage to, and loss of, the fine leaves. Given favourable weather conditions the hay should be in the stack on the third or fourth day after cutting.

Rain has a considerable damaging effect on hay, and every endeavour should be made to harvest in fine weather, even though it may mean an early or late cutting. It must be remembered, however, that while early cutting may mean reduced

A heavy crop of Subterranean Clover is difficult to handle.
[*Block by courtesy of J. Leith Gillespie.*]

weights of hay, it is offset to a great extent by increased aftermath growth. Late cutting means a loss in value of the product, also loss of leaf material. This is probably better than a crop cut at the right time and damaged by rain.

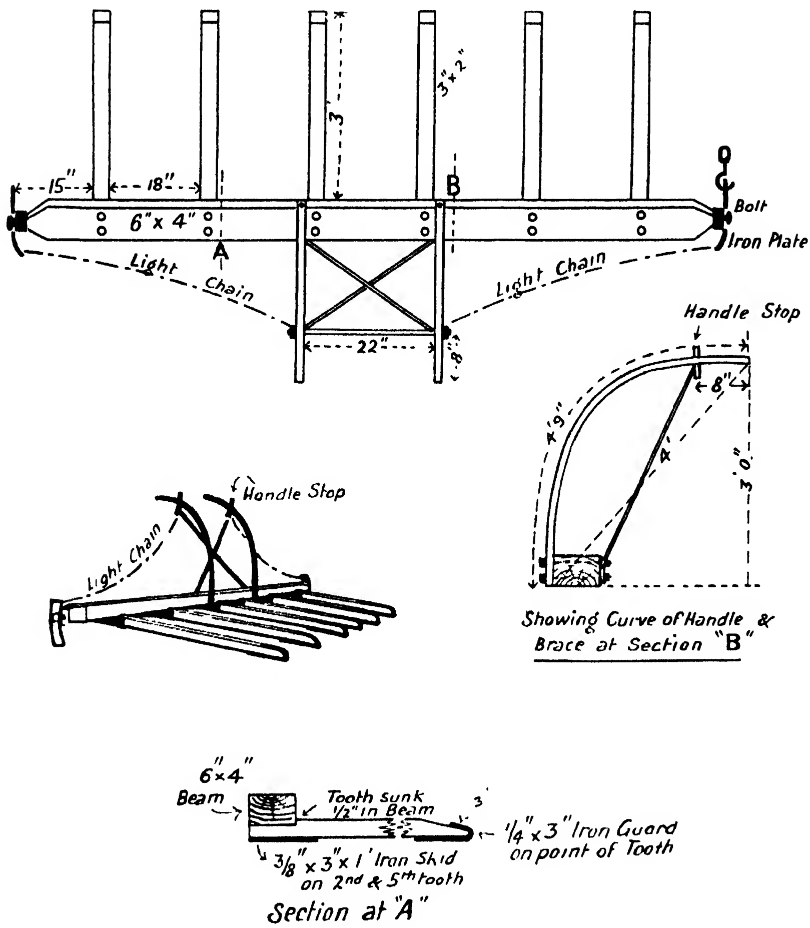
Often the work of loading hay on to drays or wagons may be considerably lightened by the use of the "Tumble Sweep" as illustrated on page 276. The load is picked up by the steel pointed teeth and is retained by the handles and two chains. The horse is hitched by leading chains to the ends of the frame.

The following two illustrations show the tumble sweep operating and tipping. When tipping, lift the handles a little so that the points catch in the ground and the pull of the horse overturns the sweep. The stops on the handle of the tumble sweep grip the ground and the horse again pulls it over to sweeping position after the load has been dropped.

It will be found if this method is adopted that a remarkably large quantity of hay can be moved to a stack at one time. This sweep is inexpensive and a great labour saver.

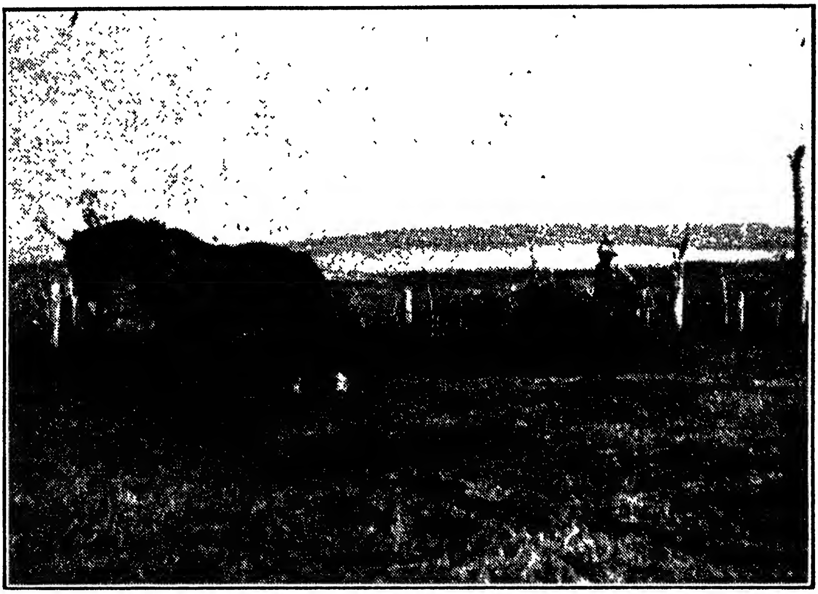
Two-horse, truck, and tractor sweeps can be obtained and have been used with great success.

6 TOOTH ONE HORSE TUMBLE SWEEP



Legend. Plan of detail of One Horse Tumble Sweep

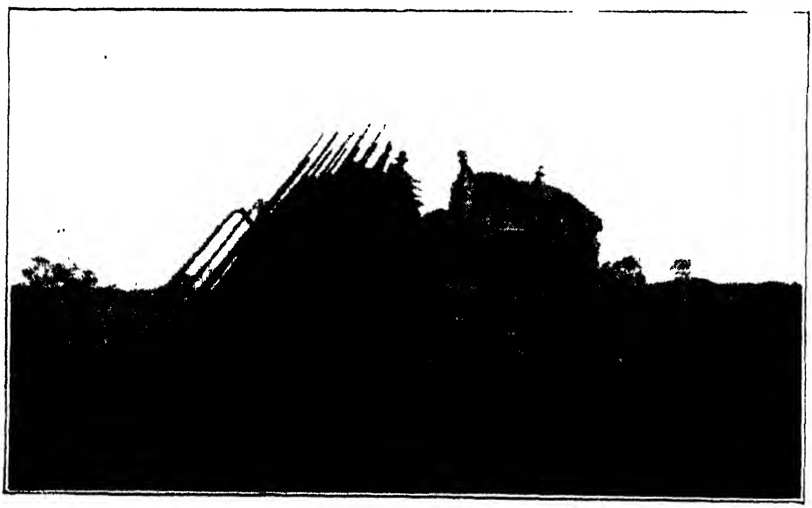
Timber Required 1 only 6"x4"x 11'6" long
6 only 3"x 2"x 3'6" long



One-horse Tumble Sweep being operated on farm of Messrs. Bayley Bros., Denmark.

Showing tumbling action of sweep, minimising handling the material.

When operating on a large scale side delivery rakes and hay loaders are invaluable for facilitating haymaking operations, and will save considerable expense in labour. The following two photographs show the side delivery rake and hay loader in operation on the property of Mr. A. Hardie, "Rosedale," Narrogin.



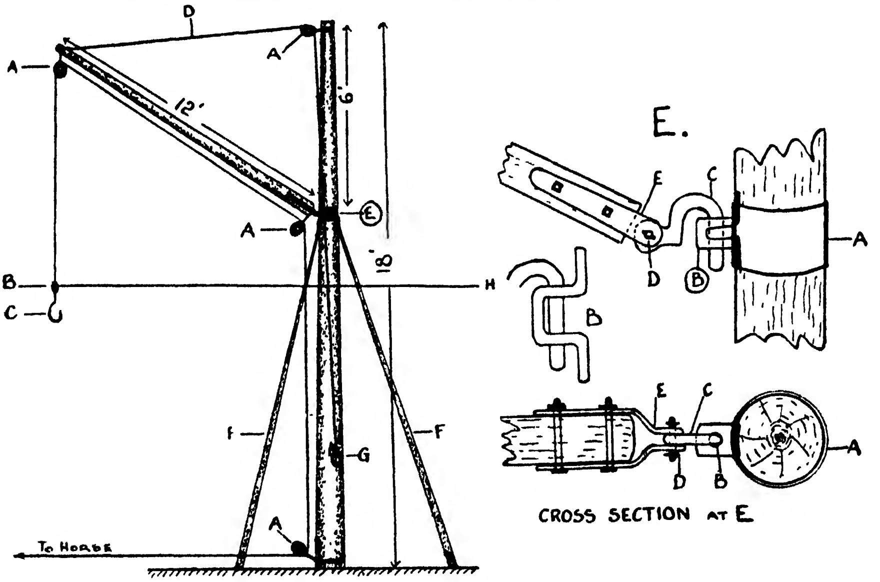
Stacking.

The material should be spread evenly over the stack and well tramped to avoid the formation of air pockets, in order to control fermentation and drying out.

Heat will be generated and charring produced if the material is too green or too damp when stacked.

During the last few years numerous inquiries have been made for some type of hoist which can be used for raising meadow hay or green material on to a stack either from the ground or waggon; it was thought that the following particulars regarding the construction of a one-horse hoist would be of value.

The following illustration gives full particulars:—



Legend—"A" Pulleys; "B" Swivel; "C" Hook; "D" Rope for raising or lowering arm according to height of stack; "E" Collar and Swivel (see enlargements); "F" Stays or guy ropes; "G" Rope tie; "H" Rope to pull material over stack.

Enlargement—"A" Collar; "B" Eye (enlarged); "C" Hook; "D" Pin and Eye; "E" Straps.

Requirements.

Poles.—Upright pole 20 feet long of which 18 feet is above ground level. The pole should be at least 8 inches at the base. The arm should be at least 12 feet long and not less than 4 inches in diameter. The arm is attached to the upright pole by means of collar and swinging attachments illustrated above 12 feet from the ground level.

Pulleys.—Four 4-inch pulleys attached as illustrated. A swivel and hook or grab attachment on end of hoist rope.

Collar and Swinging Attachment.—A six-inch collar or wound wire fitted around the pole to hold "eye" attachment. This attachment which is let into the pole is made from 14in. x 2½in. x ¾in. iron shaped as illustrated in "B" enlarged. A 1⅛in. hole is drilled to take the hook which is made from 1in. round iron. The end of the hook is flattened and a ⅝in. hole drilled to take the pin which holds the two iron straps on the arm. The two iron straps are made of 15in. x 2½in. x ⅜in. iron with holes drilled through for the pin and bolts, the iron being shaped as illustrated in cross section "E."

The photographs on the following page show a home-made hoist in action on the property of Mr. W. J. Sears, Donnybrook.

Instead of using a hook, grabs can be obtained from machinery firms for lifting the material from the waggon or ground. These will facilitate building operations considerably.

To ascertain the tonnage of meadow hay in a stack, it is first necessary to find the number of cubic feet in the stack. The results of a survey conducted by officers

of the Dairy Branch over the last two seasons indicate that the number of cubic feet of meadow hay per ton ranges from 230 to 640 with an average of 400. The great variation in cubic feet required per ton is due to four main factors, viz., Size of Stack, Composition of Material, Quality of Material, and Type of Material

Stacked. The weight of stacks surveyed ranged from 8 to 70 tons and the material stacked ranged from pure grass to pure clover; some of the material stacked had been cut late and with others left out too long prior to stacking. It is hoped to continue this survey for a few more seasons when the information obtained may be grouped according to the size of the stack and material stacked.

TOXIC PARALYSIS IN SHEEP AND CATTLE.

Stockowners are advised that the vaccine for protecting sheep and cattle against Toxic Paralysis (Botulism) will in future be supplied through the Chief Quarantine Officer (General), Commonwealth Health Department, General Post Office, Perth, to whom applications should be made direct.

It is pleasing to know that, as the result of further research work carried on by the Commonwealth Serum Laboratories, a vaccine will shortly be provided for which only one dose each year is required. This means that one handling of the animals will be necessary which will, of course, greatly decrease the expense and trouble of vaccination.

The doses recommended are:—

For Sheep—one dose of 5 c.cs.
For Cattle—one dose of 10 c.cs.

As Toxic Paralysis (Botulism) occurs during the summer it should be easy to determine the proper time for inoculation. Although conditions may vary in different districts, the best time to treat the stock will probably be about the middle or end of October each year.

THE DETECTION OF BOVINE MASTITIS.

Results of an Examination carried out to determine the Value of certain Colour-Test Outfits.

H. H. KRETCHMAR, B.Sc., A.A.C.I.

1. Recently two field test outfits for the detection of mastitis were submitted to this Department for an opinion regarding their value for the practical detection of mastitis. For the purpose of this paper, they will be called Test Set "A" and Test Set "B." To determine their suitability and degree of accuracy in Western Australian conditions, they were used to examine a number of samples of milk. The same milks also were examined microscopically and the findings then compared.

The term "Mastitis" signifies an inflammation of the mammary gland or udder. In the mildest cases it is shown only by an increased leucocyte content of the milk. If not due to a mechanical injury, some micro-organisms also should be present in the udder. In severe cases the affected quarter or quarters may be swollen and inflamed. In cases of long standing, invasion of the udder tissue generally takes place, and hardened masses of fibrosed tissue may be detected by clinical examination.

The mastitis cases of greatest importance are those which are caused by invasion of the udder with the organism "Streptococcus agalactiae" (syn. "Str. mastitidis"), for such cases apparently never recover completely, even though periods of apparent normality are experienced, and, as the disease is infectious, the affected animals are a menace to the clean members of the herd. The majority of mastitis cases are of this type.

2.—*The Principle of the Colour Tests.*

The tests are based upon the assumption that milk drawn from udder quarters affected with Streptococcic mastitis is generally alkaline in reaction, or occasionally very acid. One of the methods regularly employed by the chemist for the determination of the acidity or alkalinity of liquids is to note the change of colour produced when the liquid to be tested is added to a solution of a suitable organic colour material, generally called an indicator. In the test outfits examined the colour reagents or indicators used were brom-thymol blue and brom-cresol purple. In acid solutions brom-thymol blue is yellow: in alkaline solutions it is blue. In acid solutions brom-cresol purple is yellow: in akaline solutions it is blue-violet. Thus, if we start with one of the above indicators in the yellow condition and add an alkaline fluid to it, the colour changes to blue or blue-violet respectively. The method by which this test is carried out varies. In the Test Outfit "A" the indicator is impregnated in muslin cloth, and pieces of the cloth are clamped between two cardboard rings. Milk from the quarter to be tested is squirted direct from the teat through the muslin disc. Any change in the colour of the disc and also the presence of any clots on the muslin are noted. With the Test Outfit "B," the milk is drawn directly from the udder into a small test tube, the tube being filled to a mark etched on its side. The indicator is supplied in solution in a small bottle, and a quantity of it is measured out and added to the milk in the test tube by means of a small pipette like an ordinary eyedropper with a mark etched on the glass tube. The test tube is shaken to mix the milk and the indicator, and the resulting colour of the mixture compared with a series of standard colours printed on paper and kept in a hermetically sealed tube suplied with the outfit.

3.—*The Microscopic Examination Method.*

The testing of a herd is complicated by the fact that some animals suffering from streptococcic mastitis shed the streptococci in their milk only at infrequent intervals. Thus, in any scheme which aims at eradicating streptococcic mastitis from dairy herds, it is essential to segregate animals showing a leucocytosis of the milk (*i.e.,* an abnormal cell content), for the leucocytosis may be due to streptococci even though they were not present in the particular sample examined.

The testing of animals for disease control purposes as carried out in this laboratory takes the above facts into consideration.

The selective bactericidal properties of certain dye-stuffs is well known, *e.g.,* gentian violet at a concentration of 1 : 100,000 inhibits the growth of most Gram-positive organisms but allows the growth of most Gram-negative species. The use of brilliant green at a concentration of 1 : 50,000 to obtain a selective growth of the streptococci causing contagious streptococcic mastitis was suggested by Bryan and Huber (Bull. Inst. Past. Rev. et Anal. XXXIII., p. 1112), and is used in this laboratory.

Sterile bottles, with a mark to show the level reached by approximately 50 mls of liquid, are used as sample bottles. 5mls. of an "aged" solution of brilliant green is added to each bottle, the addition being carefully made to maintain sterility. The "aged" solution of brilliant green is prepared from Grubler's dye and sterilised distilled water prepared in a still fitted with a block-tin condenser. The concentration of dye in the solution is 1 : 5,000. The solution is kept for at least 2 weeks before use.

Before collecting the milk sample three of four streams of milk are discarded. The bottle is then filled to the 50 ml. mark. Separate samples from each quarter are taken and all precautions to avoid the entrance of extraneous organisms are observed.

The samples are incubated overnight in the 37°C. incubator. The time of incubation is about 18-20 hours.

Smears are then prepared for microscopic examination according to the method used for the "direct count," as described in Journal, Dept. Agric. W.A., XIV., March, 1937, pp. 65-73, Leaflet 504.

Samples showing the presence of leucocytes and long chain streptococci are classed as "mastitis positive." Samples showing leucocytes in excess of 100,000 per ml., but no streptococci, are classed as "mastitis doubtful." Samples showing no streptococci and having a leucocyte count of less than 100,000 per ml. are classed as "clean."

Results of Previous Tests.

The colour test principle for testing for mastitis is by no means new having been suggested by Van Slyke in 1919.

Reports of comparative tests using this principle and other methods for the detection of mastitis have been published at various times in the literature. The following two abstracts are typical and indicate the results which have generally been obtained.

1. Taken from the *Journal of Dairy Science,* XVII., No. 4, April, 1934, pp. 281, *et seq.*

" . . . . The hydrogen ion concentration " (*i.e*, the degree of acidity) "appears to be poorly suited to the detection of sub-clinical mastitis. Occasionally

. . . . the milk from a diseased udder actually is more acid than normal; generally, however, the hydrogen ion concentration is less in milk from diseased udders" (*i.e.*, is more alkaline). "In sub-clinical mastitis this difference frequently is so small as to be impossible to interpret. In acute mastitis the milk generally is alkaline; however, it is usually so abnormal in appearance under these conditions that there is no necessity for clinical identification. The hydrogen ion concentration has limited merit as a clinical method for the detection of mastitis because the variation in reaction between milk from normal udders and udders showing sub-clinical mastitis is neither consistent nor wide enough in range to permit accurate interpretation."

2. Taken from the *Journal of Dairy Science*, XX., No. 7, July, 1937, pp. 443, *et seq.*: "An analysis of nearly 7,000 comparative tests leads to the following deductions:—

The bromthymol blue test detected only 21.1 per cent. of the samples taken from quarters known to be infected with mastitis.

On samples taken from cows diagnosed as free from mastitis the bromthymol blue test gave false readings in only 1 6 per cent. of the cases.

If the bromthymol blue test is positive, there is a 92.7 per cent. chance that the cow will be found positive for mastitis on further examination.

If a bromthymol blue test is negative, there is a 55.2 per cent. chance that the cow is actually negative, and hence a 44.8 per cent. chance that the test is false."

Results from the Tests carried out locally.

1.—*Tests carried out with the "A" test outfit*: *i.e.*, the discs of muslin impregnated with bromcresol purple. 84 samples only were examined, after which it became obvious that there was little point in carrying out further tests. The first three jets of milk from the quarter were discarded and the next passed through the muslin disc.

The colour of each muslin disc as judged by a chemist, a veterinary officer, and the farm manager, turned a light but distinct blue colour with the exception of one disc which turned a deeper blue colour. In the case of the sample which produced the deeper blue colour, the milk was so abnormal as to look like a light brown jelly. Clots were observed on no other discs.

At the time of taking the samples for the colour test, duplicate samples were taken for bacteriological examination in the laboratory. Upon examination the following results were obtained:—

Ten samples gave definite indication of streptococcic mastitis.

Nine samples were abnormal but the cause of the abnormality was not determined.

Sixty-five samples showed no evidence of any infection.

An examination carried out by Mr. E. F. Twaddle, M.R.C.V.S., Veterinary Surgeon attached to the staff of the Veterinary Branch of this Department, showed that the 10 quarters which gave a positive reaction, also showed clinical evidence of infection.

The blue colour produced in all cases where no mastitis was present may have been caused by at least two factors. The indicator material may have deteriorated from age or through storage in unsuitable conditions. The more likely explanation, however, is that, due to the large surface exposed to the atmosphere, the discs absorbed an alkaline vapour, such as ammonia which is produced by rapid bacterial decomposition of organic matter in hot weather. It should be mentioned, however,

that the dairy premises where the test was carried out were very satisfactorily cleaned.

2.—*Tests carried out with the "B" outfit, i.e.,* a given volume of dye solution is added to a given volume of milk in a test tube:

One hundred and four samples were examined and the results obtained indicated that further tests would be of little value.

As in the previous test, the first three jets of milk from each quarter were rejected. The tubes were then filled to the mark and the indicator solution added.

Forty tests were made in this way. Thirty-six samples gave a negative test for mastitis; *i.e.,* the colour of the solution did not show the necessary colour change, and four samples gave the "doubtful" indication, shown by a partial colour change. When the samples were examined microscopically in the laboratory 24 showed no evidence of mastitis, but 16, including the 4 which gave the "doubtful" indication by the test outfit, showed evidence of streptococcic mastitis.

A further 64 samples were collected and examined after arrival at the laboratory, with very similar results: 62 gave a negative test with the colour test outfit and 2 gave a "doubtful" indication. Upon microscopic examination 23 samples showed no evidence of mastitis, but 41, including the 2 samples which gave the "doubtful" indication by the test outfit, showed definite evidence of streptococcic mastitis. Of the four tests which were carried out in the field with a "doubtful" indication result, two were a semi-gelatinous secretion having no resemblance to milk, and a third was very abnormal having many clots and pus.

The results of these tests may be tabulated as follows:—

Results obtained from the 84 *Examinations carried out with the Test Set* "A."

Indications by the microscopic method.	Indications given by the Test Set on corresponding samples.	Clinical Findings.
10 positive cases ...	9 positive tests ... ... 1 strong positive	10 clinical cases, including 1 milk very abnormal
9 doubtful cases ...	9 positive tests	
65 clean animals ...	65 positive tests	

Results obtained from the 104 *Examinations carried out with the Test Set* "B."

Indications by the microscopic method.	Indications given by the Test Set on corresponding samples.	———
57 positive cases ...	51 negative tests ... ... 6 doubtful tests	1 milk very abnormal 2 milks very abnormal
47 clean animals ...	47 negative tests	

The results of these tests thus agree with the findings of previous workers that the colour test (H-ion concentration test, pH test) is of little value for the diagnosis of streptococcic mastitis.

In view of these results the use of colour test outfits for the detection of cows suffering from mastitis cannot be recommended.

THE CONTROL OF MUSSEL SCALE

(Lepidosaphes ulmi L.)

By H. R. POWELL, B.Sc. (Agric.),
Horticultural Adviser.

Mussel Scale is a common pest of the apple, although it is not necessarily confined to this host. In most orchards its presence can be detected on "Yates" and "Jonathans"—varieties to which the scale shows a somewhat pronounced partiality. Infestation is not always slight; in fact, it can be so severe that affected trees have their wood literally plastered with scales.

There is no doubt that this scale is spreading amongst the orchards in the southern portion of the State, despite parasitism and the winter use of red spraying oils.

The purpose of this article is to give some information on—

1. The life history of Mussel Scale.
2. The date of emergence of larvae from eggs retained under the shield-like covering of the female scales of the preceding generation.
3. Two methods of control that have been found to be satisfactory on the orchards of Messrs. E. Greenslade and S. Scott, of Mount Barker.

1. *Life History.*—There appears to be only one generation of Mussel Scale each year, the young or larvae hatching from egges retained under the old scales of the females. These old scales are very tenacious and remain firmly attached to the bark for years.

The larvae, light brown in colour, possess legs six in number that enable them to move freely to portions of the tree that offer scope for permanent settlement. Once settled in position, usually under cover, or on the weather protected sides of the stem and branches, the object of the young scales is to literally "dig in" as quickly as possible. The sap sucking mouth-parts are inserted into the bark and the devitalising effect on the host is begun.

With disuse the legs atrophy, and on the outer surface of the body a scaly secretion slowly forms into a hard protective covering, that persists long after the insect has completed its life cycle.

The female scale, after several moults, is at maturity darkish grey in colour, slightly curved and elongated, with the widest portion at the distal or posterior extremity—hence the derivation of the name "Mussel."

The male scales, however, are by no means as conspicuous, being much smaller and lighter in color. They give rise eventually to winged forms that fertilise the females and shortly afterwards die, through imperfect development.

The eggs then mature under the female scales.

2. *The Determination of the Date of Emergence of Larvae.*—The most vulnerable period in the life cycle of all scale insects is that extending from the hatching of the eggs, or from the birth of living larvae, as with some scales, viz., San José, to the period before the formation of the hard shield-like covering, when their bodies are devoid of protection.

To determine the time of hatching, weekly visits were made to Mr. E. Greenslade's orchard from the beginning of October, 1937, to December, and it was not until the 10th of the latter month that maximum emergence was noticed. The newly hatched scales were present in large numbers, taking up permanent positions on practically every available portion of twig, branch and stem.

3. *Control.*—(a) As the customary use of Red Spraying Oil had failed to check the scale on Mr. Greenslade's property, it was decided that a Lime-Sulphur Spray should be substituted. This was applied on the 20th September at a strength of 1:12, care being taken that the trees were well covered; one "Yates" heavily infested was left unsprayed as a control.

For a considerable time the sprayed trees appeared to be unaffected by the spray. The old scales, when scraped away with a knife, contained eggs that appeared to be in fresh viable condition—in every way comparable to those found

The Oyster Shell Scale; a, female scale from below, showing eggs; b, same from above; c, female scales; d, male scale; e, male scale, enlarged.

(*After Dr. L. O. Howard.*)

on the unsprayed tree. From the beginning of December, however, young scales began to appear on the unsprayed tree, but on the sprayed trees, even well into February, no live scales could be found.

Thus, it can be stated that lime-sulphur at a strength of 1:12, applied in the third week of September, exerts a complete control over Mussel Scale without damage to the tree.

Control (*b*). Having determined the time of emergence of the young scales it appeared that the use of a White Oil Spray at this period would prove satisfactory.

Accordingly, the unsprayed tree on Mr. Greenslade's orchard was sprayed with White Oil at a strength of 1:40 on the 10th December, and on Mr. Scott's orchard two "Yates" very heavily infested with Mussel Scale were sprayed a week later with White Oil at strengths of 1:40 and 1:60 respectively. Care was taken that every portion of the trees was covered by the spray.

On subsequent visits it was impossible to locate any live scales on the sprayed trees, thus showing that the control of Mussel Scale by White Spraying Oil at the strengths used was very efficient.

It is quite possible that weaker concentrations of White Oil, combined with Nicotine Sulphate, will prove effective in exerting a control, not only for Mussel Scale, but for Red Spider and Bryobia Mite as well, if used during mid-December. Next season steps will be taken to test this.

CONCLUSIONS.

1. Mussel Scale, if left unchecked, has a serious devitalising effect upon infested fruit trees.
2. Maximum emergence of young scales occurred during the middle of December in 1937.
3. Effective control consisted in spraying with
   (a). Lime Sulphur 1:12 during the third week of September.
   (b). White oil 1:60 during the middle of December.

WARNING.

1. Lime Sulphur should not be used at the strength stated if the spurs are bursting, otherwise serious damage will result.
2. As hot weather may be expected during December it is necessary that cool days be chosen for the application of White Spraying Oil.

FOURTH INTERNATIONAL GRASSLAND CONFERENCE.

The report of the Fourth International Grassland Congress held in Great Britain from July 8th to 23rd, 1937, indicates that 450 delegates from 37 countries were in attendance.

Under the presidency of Professor R. G. Stapledon, a large range of papers was submitted and discussed, and the exchange of information and ideas is anticipated to accelerate the rate of grassland research in the various countries.

Quite a number of topics of interest to farmers in Western Australia were considered, and the following notes give some brief outline of the more important of these.

In his presidential address, Professor Stapledon emphasised that the proper use of grass and grassland is a matter of systems of farming and, therefore, of facilities. The regional survey method was suggested as the best basis of pasture development, and, following this survey, the use of the right strain of the comparatively few species that really suit the needs of any well defined natural region. In considering the various factors affecting the establishment and maintenance of a pasture, the effect of the grazing animal was considered the most important.

The value of legumes in pasture was referred to in very emphatic terms. "No grassland is worthy of the name unless a legume is at work. Make the conditions suitable for the legume, and manage the sward to favour the legume as well as feed the animal—the battle will be won."

The problem of management was surveyed as being threefold:—

Firstly—How to produce grass when it is most urgently wanted.

Secondly—How to farm grass not only with a view to maintaining but also to progressively increasing soil fertility.

Thirdly—How to manage grass so that young, vigorous, succulent grass of maximum food value is available for the animal.

In discussing this, rotational treatment of the farm as a whole was suggested as a means of maintaining and increasing pasture production. The importance of selecting strains to supply growth during the winter was mentioned also.

Amongst the plenary papers the subjects discussed included grass-drying, the nutritive value of pasture for wool production (which directed attention to the necessity of investigating pastures by considering their effect on the quality of the wool produced), plant breeding, and the selection of plants to suit certain localities. Klapp tendered a paper on "The Principles Governing the Value of Herbage Plants for Hay and Pasture" and concluded that the capacity for yield and after growth is governed by the interaction of—

(a) amount and vigour of pasture which remains after cutting or grazing;

(b) the duration of the rest period between two cuts or grazing periods.

The product of (a) and (b) is certain to be quite different under mowing and under grazing.

Virtanen explained the old established fact that non-legumes were benefited by association with legumes. He showed that recent exact work with sterile culture technique had demonstrated that nitrogenous compounds are excreted into the soil from the legume nodules and that this excretion commences immediately on the formation of nodules. The sequence by which atmospheric nitrogen was turned into products available for plant food was explained.

The section dealing with grass-land ecology was devoted principally to the development and maintenance of pasture lands in different countries, and particular attention was paid to range pastures and pastures in arid climates.

The most important papers dealing with seed mixtures were those recording the tendency to lighter rates of seeding in areas of low rainfall. Two papers by Australians were submitted—one by Whittet of New South Wales and the other by Griffiths Davies of South Australia. Thomas of Aberystwyth, Wales, stressed the importance of strain in herbage plants. Improved strains outyield ordinary commercial strains both as hay and pasture. How the effective grazing season could be prolonged by resting a paddock, or by conserving the feed in situ was described.

A. B. Adams of Muresk Agricultural College, Western Australia, contributed a paper to the plant breeding, genetics and seed production section on "The Strains of Subterranean Clover which are grown under Western Australian conditions."

Further interesting papers to this section dealt with the difficulties of the plant breeder working with pasture types. It was suggested that, while the best indication of productivity is to be found in the height of the plant, its degree of leafiness and tillering, the elimination of individuals has to be based on other more readily distinguishable characters such as early ripening, resistance to disease and frost, etc. In considering seed production from pasture grasses, it was stated that very leafy strains had in their favour—(1) greater persistency, although combined with lower seed yields per acre; (2) the threshed straw is of better feeding value than the straw of hay types.

Methods suggested to overcome the disabilities of pasture strains in relation to seed production were:—

1. The selection of deep fertile land in a suitable climate.
2. Sowing the seeds, except those of Rye Grass, in wide drills without cover crops.
3. Adequate manuring.
4. Mechanised cultivation and harvesting.
5. Weed suppression by the use of chemicals.

The difficulties of harvesting of clover seed, and the incidence of pasture pests were also discussed.

The fertility of the soil and the manurial requirements of grassland provoked a series of valuable contributions.

The influence of a deficiency of phosphate in contributing to mineral deficiency diseases in live stock was referred to by Hanley who traversed the results of experiments at Cockle Park into the need for lime and phosphate in grassland improvement.

A contribution on the manuring of grassland in arid regions was made by a delegate from Hungary. He reported that farmyard manure was less valuable on grassland than on arable land, but this was possibly explained by the higher humus content of the grassland swards. The conclusion was that no material improvement could be expected as a result of manurial treatment alone. The aeration of the soil, a deeper crumb structure, and the conservation of winter moisture were considered to be of more importance.

Further papers reported the success attending regular manurial treatment of pastures principally using phosphates. The ratio of potash to nitrogen in assisting

growth and protein production in a pasture was discussed also. The advantages gained by the use of nitrogenous fertilisers were presented in papers from Sweden, the Netherlands, and Germany. In the latter paper the prerequisites necessary for the economic use of nitrogenous fertilisers were suggested to be:—

1. Suitable regulation of the water table, 1 to 1.2 metres being suggested.
2. Adequate humus content of the soil.
3. A dense sole.
4. The form of fertiliser to be selected according to soil conditions.
5. Adequate supply of other plant nutrients.
6. Most favourable time for application being the months of vegetative development.

The nutritive value of pastures was discussed in papers presented on "The Chemical Changes that Occur in the Stem, the Leaf, and the Whole of Grasses with Advance to Maturity." The bearing of these results in indicating the superiority of some strains over others was pointed out.

An interesting paper by Konig of Germany dealt with the influence of different manurial treatments upon the composition and value of the herbage of permanent grassland. The direct and the indirect influences of manurial treatments were discussed. The former varies the chemical composition of the plant according to the fertiliser used, *e.g.*, the increase of protein content is produced by the use of nitrogenous fertilisers, while an increase of phosphoric acid, potassium or calcium is brought about by the use of the element in question. The indirect influence is brought about by the alteration of botanical composition.

The method of determining the fertiliser requirements of soils by analysing the ashes of the hay crop was discussed also.

L. I. Jones, of Aberystwyth, suggested methods of studying the comparative values of pastures as measured by the grazing animal.

The subject of grass-drying in England was covered in an excellent paper by Roberts, who, in addition to describing the process, gave an outline of the cost of the method.

Papers also were presented dealing with losses in fodder conservation, and the advantages and disadvantages of silage made by various methods.

In the section devoted to the management and the economics of pasture, references were made to the effect of various systems of grazing. Close grazing resulted in weaker growth with the plots becoming increasingly weedy. Plots harvested at intervals gave larger yields than those cut at more frequent periods. Root studies indicated a marked reduction in weight of roots and of rhizomes where the grass was cut close throughout the season.

A paper dealing with "New Zealand Grassland" referred to the reversion of sown pasture to bushland where grazing and fertilisation were not carried out. The tendency to more simple grass-clover mixtures in sowing was stressed with the suggestion of a development towards a segregation of pasture types into different paddocks instead of more complex mixtures in all paddocks.

Topdressing with fertiliser is the greatest single factor in grassland management, while harrowing has decreased in favour. The trend towards smaller fields with rotational grazing also was mentioned.

Orr contributed a paper on "The Economics of Grass Cultivation" in which a survey of studies into the effect of grazing on the constituents of the sward was made. Attempts to manage the grassland so as to supply the needs of stock without allowing the sward to suffer were outlined. The report concludes with papers

dealing with "Methods of Determining the Botanical Composition of Pastures and with the Size of Paddocks."

The publication embodying the papers contributed makes a most interesting and valuable source of reference to the trends in grassland research throughout the world, and the editor deserves congratulation on the form in which this report is arranged.

An invitation extended by Dr. D. S. Huizinga to hold the fifth Congress in the Netherlands in 1940 was accepted. A further invitation was extended by Count Teleki to hold the sixth Conference in Hungary in 1943.—M. Cullity, Sen. Agric. Adviser.

BEE COMBS.

Preparation and Manipulation.

By H. WILLOUGHBY-LANCE.

Next in importance in the production of honey to the stocking of hives with pure bred bees of a good strain, is the provision of good combs, and the careful and intelligent arrangement of them in the hive. Very often this is overlooked by beekeepers, either owing to lack of knowledge or carelessness.

The invention of the movable frame and wax foundation and the centrifugal extractor during the last century entirely revolutionised beekeeping, and enabled beekeepers to regulate the rearing of brood, reduce swarming, and produce larger crops of honey; and the scientist to study with exactitude the economy of the hive. The days are past when at the end of the season the beekeeper, to obtain the crop of honey, had to either destroy the bees or drum them into another skep or box, cut out the comb, and separate as far as possible the brood comb from the combs of honey, which were crushed and often contained small quantities of eggs, brood, or pollen. The honey was then strained; but all the straining could not rid the honey of the flavour of the brood and pollen.

Present-day methods are absolutely hygienic, as anyone can testify who has witnessed the removal of honey from the hives, and its extraction and preparation for the market.

Frames.—Good combs can be used for many years for brood rearing, or the storage or honey. To obtain these a good pattern of Root Hoffman or other standard self-spacing frame should be used, and the Victoria pattern with square sides is recommended.

There are four sizes of standard frames at present in use in Australia. These are similar to those generally used in America. The dimensions of our frames, however, are different from those generally used in Britain. All four sizes are of the same length, that is 19 inches long, with projecting tags for suspension in the hive, the only difference being in the depth. The standard size is 9¼ inches deep, and is generally used by all the large beekeepers for both the brood chamber and the supers or honey chambers. The three-quarter depth or W.S.P. Frame, which is 7¼ inches deep, has only come into use recently and is favoured by some beekeepers as it allows more gradual expansion of the hive for brood rearing or storage purposes.

The Bolton or Ideal Frame is 5⅜ inches deep and was originally introduced for the same purpose as the W.S.P., and for controlling swarming by Bolton's

method of reversing the combs. The half depth is 4½ inches deep and is intended for use as a super for honey storage when the flow is not heavy enough for the full depth frame. The advantage of using this frame for storage as against the Ideal or W.S.P. is that the standard extractor will take two frames in the place of one standard full depth; whereas it will only take one Ideal or W.S.P.

Another important recent use for the half depth or Ideal Frame is to place a box of these full of honey on the hive as a food chamber for the winter and spring brood rearing. Colonies with food chambers are ensured against starvation and come out stronger and start brood rearing earlier than those with a scarce supply of honey.

Foundation.—All frames should be strongly wired and fitted with full sheets of foundation. The only exception is where swarms are hived. These may have starters instead of full sheets, as swarms are in a condition for comb building and invariably build worker comb in the first instance. The practice, however, is questionable, as some bees are bad comb builders and do not always build straight combs, and sometimes, even when foundation is given, bush bees that are used to building comb just as they please in hollow trees, will make a bad job of it.

There are three important reasons why full sheets should be used:—

(1) Experiments have proved that bees consume from 12 to 16 lbs. of honey to make one pound of wax, therefore, for every pound of wax foundation supplied, the bees will store an extra 12 to 16 lbs. of honey.

(2) By giving a straight full depth vertical foundation, the bees will build thereon in the right direction, and fill the frame with a straight good comb, so that any comb can be removed without cutting or breaking, as required by the Bees Act.

(3) As the foundation is embossed with the bases of worker cells, the bees will build all, or nearly all worker comb. If only starters are given, the bees just before swarming time, and often when there is a honey flow on, will frequently build drone instead of worker comb. Then when the queen lays eggs in these cells, she will lay drone eggs, and hundreds, or even thousands of drones will be hatched instead of workers, and the honey crop will be much reduced.

It will, therefore, be obvious that it pays well to use full sheets of foundation.

Wiring.—There are several methods of wiring. Three of the most general are illustrated herewith. Fig. 1 with four parallel wires is the simplest, and probably the most general, and is adapted for electrical embedding, whereas the other two have to be embedded with a warm spur wheel. Frames as purchased usually have four small holes drilled in the end bars ready for the wire. Two small tacks should be driven half home, one near the top hole and one near the bottom hole of one end bar at Nos. 1 and 8. Now take the reel of wire, which should not be of smaller gauge than No. 28 B.W.G.—unless the new non-stretching wire is used—when No. 30 will be quite strong enough. This wire is now obtainable from suppliers of bee requisites.

Thread the wire through the holes and twist the end round the tack; drive it home; stretch the wire until it twangs like a musical instrument; twist round the other tack and drive home. When fitting the foundation, the frame should be placed upside down and the foundation threaded between the wires, so that the wires are on alternate sides of the foundation, which must now be secured to the top bar. If an electrical embedder is used, contact is made at each end of the wire for a few seconds until the wire is warm and sinks into the wax. If a spur wheel embedder is used, this is heated in a flame and run along the wire quickly and evenly and presses the wire into the warm wax.

The wiring of Figures 2 and 3 is similar, but the method of threading varies, as shown by the numbers. Some beekeepers use No. 26 galvanised iron wire for wiring Fig. 3, which makes a very strong comb not liable to break in the extractor, but the bees sometimes object to the thick wire and eat away the wax along its edge.

For Ideal or Bolton frames, or for half depth frames for supers, two cross wires are usually sufficient. For W.S.P. frames, which are used for both brood chambers and supers, three cross wires should be used.

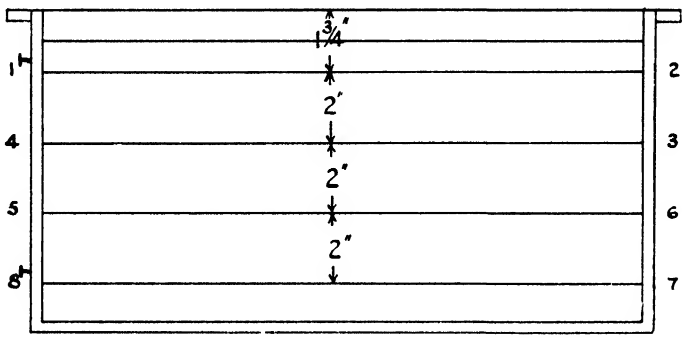


Fig. 1.

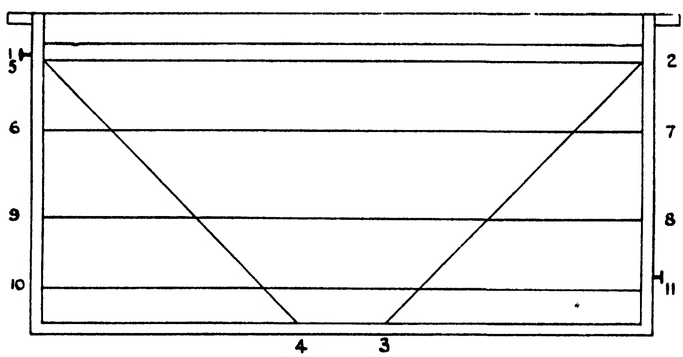


Fig. 2.

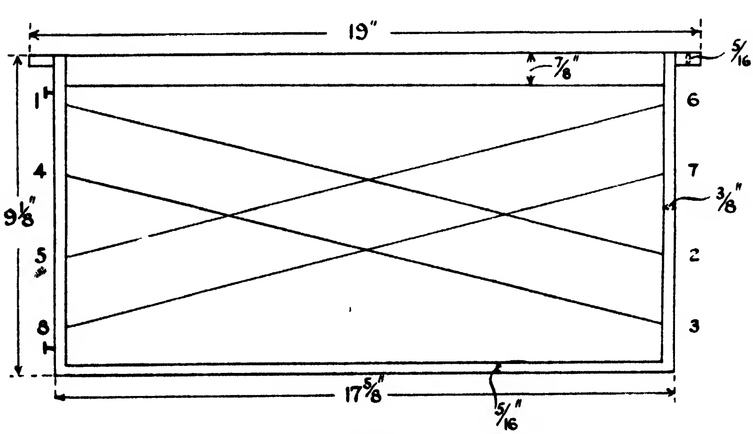


Fig. 3.

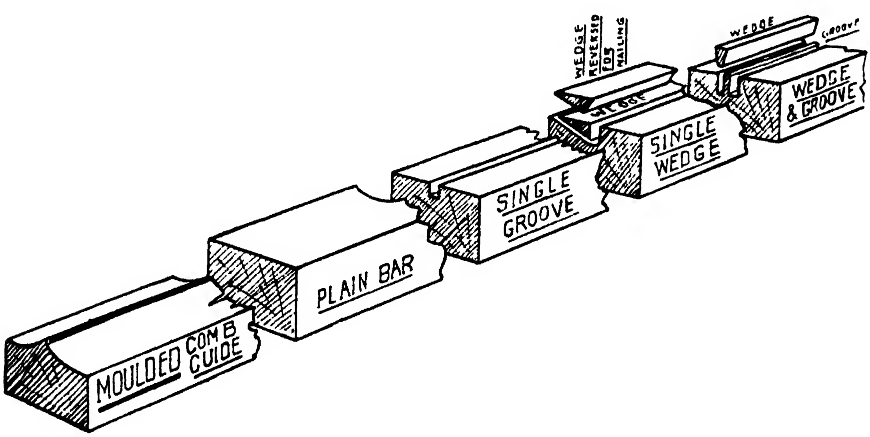
Fitting Foundation.—There are several methods of fixing the foundation to the top bar.

Wedge and groove frame.—With the wedge and groove pattern of frame, the foundation is inserted in the middle groove, and the wedge pressed or tapped firmly into the side groove, so as to press the middle strip tight against the foundation. The objection to this method is that the grooves are harbours for wax-moth, which burrow into them for the purpose of pupating, eating away the wood to make their cocoon.

Single wedge frame.—With this pattern the wedge is removed from the bar and the foundation inserted; the wedge is then turned upside down, and replaced in the bar, and pressed firmly against the foundation. Four or five thin nails are then driven in, in a slanting direction through the wedge, to hold it tight against the foundation. In this pattern there is not much opportunity for the wax-moth to do damage.

Moulded comb guide is another pattern, very little used, and I do not recommend it.

Single groove.—This is probably the best type to use. The foundation is inserted into the groove and hot wax run along both sides of the foundation. This fixes it firmly into the bar, and there is then no possibility of the foundation falling away from the bar with the weight of the bees, as often happens with the wedge and groove, and single wedge, unless the beekeeper is careful to make a firm job.



For Embedding the Wires.—A board $^3/_4$in. thick should be made so as to fit easily into the frame. This is placed on the bench, and the frame placed over it, so that the foundation lays on the wood; the spur wheel can then be run along the wire without breaking the foundation. When using an electrical embedder, it is advisable to place a similar board, with a weight thereon, on top of the foundation, to press the wire on to the foundation before making the electrical contact.

Wired Foundation.—The wiring of frames and fitting of foundation is one of the beekeepers most tedious jobs, and is a comparatively slow process. Much thought and time have been spent by inventors to improve the strength of combs and the saving of time; such as aluminium foundation and other substitutes for wax, but none has been adopted to any extent. Two of the latest are three-ply foundation and wired foundation, both of which are being used to a large extent in America. The three-ply foundation is made of three very thin sheets of wax,

the centre one being of vegetable wax for strength, and the two outer ones of natural beeswax. This is used and fitted in the same way as ordinary foundation.

The wired foundation was first made by Dadant & Sons, U.S.A., and is now also made in a slightly different pattern by Pender Brothers, N.S.W. I have tried the Dadant foundation, which is used in special frames with slotted bottom bars, and find that it does away with the tedious wiring and embedding and saves about 75 per cent. of time. The combs drawn out by the bees are as perfect as one could desire—working cells from top to bottom bar with only an occasional pop hole in the corners.

The Pender wired foundation is similar, but has straight vertical wires instead of crimped, and the fixing to the bottom bar is slightly different, but the resultant combs should be as good as the Dadant, and I would strongly recommend bee-keepers to give it a trial.

The fitting of wired foundation into frames is a very easy matter. The frame to be used is the single wedge, or single groove. If obtainable, the square wedge is preferable to the V. type. All that has to be done is to insert the foundation into the frame, place the wedge into position, and nail; or in the case of single groove, run the hot wax into the groove.

Building the Combs.—The next job is to get the frames of foundation drawn out into full combs. They may be given to either swarms or to colonies that are rapidly increasing in numbers, or when there is a prospect of a honey flow. If the swarm is small, or the bees are only increasing slowly, it is best to give only two or three frames of foundation at a time, because if there is only a little honey coming in, the bees often tear down some of the foundation to use on other frames. Also in cool weather an excessive number of frames of foundation reduces the temperature of the hive.

Position of Combs.—Now as to the situation of frames in the hive. It must be remembered that the brood nest is usually in the centre and warmest place of the hive, and that the bees cluster thereon to hatch the brood. The outer circle of these centre combs contains pollen and honey, and the combs next to the brood nest also contain pollen and honey, being easily accessible to the young bees that have to feed on them to make the chyle or milk food for the larvae. Next come combs of honey, and lastly, if there is still room, combs in course of construction.

Increasing the Brood Nest.—The natural place, therefore, for undrawn foundation is on the outside. However, in warm weather, when there is plenty of honey coming in and breeding takes place, single combs may be placed next to the brood nest, as this hastens their drawing out, the bees being anxious to fill them with brood or food. A good time to get the combs drawn out is when the spring is well advanced and the brood chamber full of bees, brood, and honey. It should be the aim of all beekeepers to get two chambers full of brood and honey before trying to secure any surplus honey. To do this, take a body the same size as brood chamber to use as a second storey. Now take two or three frames of brood out of the bottom chamber and place in the centre of the second; close up the remaining brood combs and place frames of foundation on each side between them and the combs of honey, first damaging the cappings of any honey above the brood. The bees will then remove the honey and the queen will deposit eggs therein; otherwise there might be a bar of honey between the two chambers which the queen would not pass. If there is only a little honey in the brood combs placed in the second storey, it would be as well to transfer a comb of honey with them. Now fill up the second chamber with the frames of foundation, and close up. If the season is good, and the queen young and of a good strain, it is surprising how quickly she will fill the two chambers ready for the main honey flow, when a further one or two bodies may

be placed on top. No excluder will be needed if the beekeeper manipulates the frames in the two lower chambers correctly, as the queen seldom climbs to the third storey unless overcrowded below.

Manipulation of Combs.—In the manipulation of hives with old combs, the dark worker combs should always be placed in the centre where the brood nest is, and any drone combs on the outside next to the walls of the hive, as this is the last place the queen will lay in, unless, of course, drones are required for mating purposes, in which case one or two such combs should be placed in the centre. Drone combs may also be placed in the supers for the storage of honey.

Dark worker combs are also useful to place in the second storey next to the brood, or with a swarm that has been hived; one comb of brood and one dark worker comb for the queen to lay in will often prevent the swarm from absconding.

Renewal of Combs.—The cells of combs that have been used for the rearing of many generations gradually become smaller, as each chrysalis leaves a thin skin behind it. When the cells are noticeably small, the combs should be replaced, otherwise the young bees will not be able to develop to their natural size.

Badly damaged combs, or those with an excessive amount of drone cells, or those which have sagged and been patched up by the bees, so that there are a number of irregular cells that cannot be used for brood rearing, should never be placed in the brood nest, but should be taken away and melted down—otherwise there will be so much waste space where every inch is valuable, brood rearing of the workers will be restricted, and the tendency to swarm will be increased.

Stretched cells on the upper portion of the combs in the lower brood chamber have a tendency to act as a bar to the queen in passing from one chamber to the other—should there be any of these, they should be placed in the second chamber. Careful sorting and arrangement of all combs is of great assistance to the beekeeper in the prevention of swarming and the storage of surplus honey.

THE FRUIT INDUSTRY IN WESTERN AUSTRALIA.

GEO. W. WICKENS,
Superintendent of Horticulture.

FRUIT PRODUCTION AND EXPORT.

It will be noted from figures given hereunder that 58.8 per cent. of the total area under orchards in Western Australia is devoted to apple growing, and it will be realised that when, for any reason the apple crop is light, the gross fruit production in that season suffers to a much greater extent than when any one of the other kinds of fruit has a crop below the average. During the past few years our apple trees have cropped so consistently that we began to flatter ourselves that growers had by up-to-date methods eliminated the bugbear of low yields, but "pride goeth before a fall," and very many apple orchards in Western Australia during the season under review had little more than half a crop: though the situation was saved to a considerable degree by younger trees coming into bearing and some good crops on old trees in certain districts. Those growers whose orchards are in the areas devastated by hailstone and cyclonic wind storms last year have had a particularly bad spin, for their trees were carrying record crops of fruit, much of it ready for marketing when it was destroyed by storms, and this year those trees, in common with many others which missed the damage, are just having a rest, recuperating and getting ready for a special effort next season. I think

it is probable the dry seasons of 1935-36 and 1936-37 were contributory causes to the partial failure in 1937-38: but in 1934-35 the apple crop comprised 1,228,300 cases: in 1935-36 1,235,849 cases: in 1936-37 though the returns show only 1,045,369 cases there is no doubt the production amounted to 1,400,000 cases, and with or without dry weather it is unusual for apple trees to crop heavily in successive seasons, so, as stated above, they returned to normal and rested.

With supplies to our best overseas market—United Kingdom—regulated by quotas on the basis of average quantity shipped during the preceding three years' period, this year's light crop following on last year's partially lost crop may, next year, affect Western Australia very seriously, our exports to the United Kingdom during the preceding years being as follow:—1936, 619,129 cases: 1937, 429,660 cases; 1938, 337,785 cases. If the quota allotted to Western Australia is based on the average of the three years mentioned then we should be limited to an export of 462,191 cases, and if the promise of heavy crops now showing in the buds of apple trees throughout the State is fulfilled, that quantity will be greatly below our requirements, as illustrated thus—

Area under *bearing* apple trees 1934-35, 8,617 acres; production 1,228,300 cases = 14 cases per acre.

1935-36—*Bearing* area, 9,027 acres; production 1,235,849 cases = 136 cases per acre.

1936-37—*Bearing* area, 9,486 acres; production 1,400,000 cases (actual returns plus estimated loss) = 147 cases per acre.

Figures for area and production in 1937-38 are not yet available, but the bearing area will increase to at least 10,000 acres in season 1938-39 which, with a crop of 150 cases per acre would yield 1,500,000 cases. Markets in sight, if the United Kingdom quota is as stated, are—

	Cases.
United Kingdom	462,191
Consumption within Western Australia	400,000
Overseas markets, other than United Kingdom, say	235,000
Total	1,097,191
Balance on hand	402,809

constituting a very grave problem indeed.

From particulars listed hereunder it will be seen that the quantity of pears shipped this year only amounted to 27,417 cases: this compared unfavourably with 31,111 cases in 1937, and 45,785 cases in 1936: and was due in a large measure to export varieties being definitely on the light side in cropping.

Table grapes showed a gratifying increase, and the number of cases exported—72,752—constitutes a record for Western Australia, the largest total previously being 61,745 cases which were sent overseas last year, 1937.

Oranges exported only reached the small total of 3,480 cases, and considering that the average annual crop is upwards of 300,000 cases it can be seen that the quantity exported has little effect in relieving the local market.

Full particulars showing the quantities of each kind of fruit exported for the year ended 30th June, 1938, are shown hereunder. These include small quantities shipped in the first six months of the year between 1st July, 1937, and 31st December, 1937, comprising 3,027 cases of apples; 2,736 cases of oranges; 12 cases of grape fruit; 138 cases of lemons; 208 cases tomatoes; 9 cases peaches; 3 cases apricots and 3 cases of plums.

EXPORT OF FRESH FRUIT FROM WESTERN AUSTRALIA TO OVERSEAS MARKETS FOR YEAR ENDING 30TH JUNE, 1938.

Destination.	Apples.	Pears.	Grapes.	Oranges.	Lemons.	Grape Fruit.	Peaches.	Plums.	Apricots.	Tomatoes.	Melons.	Pomegranate.	Total.
	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.
London ...	206,625	18,001	5,474	1	...	3	8	...	4	...	...	...	230,116
Southampton ...	13,595	...	488	...	...	...	...	...	...	...	...	...	14,083
Hull	10,420	...	...	...	...	...	...	...	...	...	...	...	10,420
Liverpool ...	43,882	...	450	...	...	...	...	...	...	...	...	...	44,332
Glasgow ...	63,263	...	...	...	...	...	...	...	...	...	...	...	63,263
Hamburg ...	73,200	2,208	621	...		...	...	...	...	...	...	...	76,029
Stockholm ...	74,632	5,914	1,390	...	...	...	...	...	...	...	...	...	81,936
Singapore ...	26,719	629	22,333	2,151	175	10	80	253	...	211	136	1	52,698
Palembang ...	86	...	7	...	...	...	...	...	...	...	...	...	93
Penang	4,276	64	3,986	558	2		5	3	...	1	...	...	8,895
Belewan ...	525	4	214	4	...	...	...	...	...	...	...	...	747
Batavia... ...	3,012	219	2,314	74	...	...	5	25	...	18	20	...	5,687
Sourabaya ...	1,255	177	1,501	10	...	...	...	73	...	...	...	...	3,016
Port Swettenham	4	...	3	...	...	...	...	...	...	...	...	...	7
Samarang ...	873	30	1,429	32	...	...	...	...	...	...	...	...	2,364
Bangkok ...	431	2	326	...	...	...	...	1	...	...	...	...	760
Saigon	988	30	708	10	...	...	...	...	...	...	...	...	1,736
Rangoon ...	110	...	900	...	...	...	...	...	...	...	...	...	1,010
Malta	...	...	...	35	...	15	...	...	...	...	...	...	50
Aden	1,012	...	...	...	...	...	...	...	...	...	...	...	1,012
Durban ...	173	...	...	...	...	...	...	...	...	...	...	...	173
Bombay ...	1,986	...	991	...	...	...	...	...	...	...	...	...	2,977
Calcutta ...	918	35	1,787	81	...	...	...	...	...	...	...	...	2,821
Colombo ...	2,266	75	26,272	509	...	14	5	33	...	...	...	...	29,174
Madras	921	29	1,165	15	...	...	...	...	...	...	...	...	2,130
Port Said ...	7,531	...	393	...	...	...	...	...	...	...	...	...	7,924
Totals ...	538,703	27,417	72,752	3,480	177	42	103	388	4	230	156	1	643,453

Acreage and Production.

The total area under orchards for season 1936-37 (latest figures available) show a small increase over that of the previous year, the difference being 647 acres, from 21,494 to 22,141. The main increase is represented by apple trees—269 acres. Other small increases are orange trees, 75 acres; almond trees, 49 acres; and peach trees, 45 acres.

Full particulars of acreage and production of all fruits, including vineyards, for season 1936-37 (latest figures available) are as follow:—

ACREAGE AND PRODUCTION OF FRUIT IN WESTERN AUSTRALIA.

Season 1936–37.

ORCHARDS.

Kind of Fruit.	Area.			Production.
	Productive.	Unproductive.	Total.	
	acres.	acres.	acres.	
Oranges	2,608	450	3,058	302,235 bushels
Mandarins	139	41	180	14,981 ,,
Lemons	426	73	499	63,685 ,,
Other Citrus	18	27	45	1,677 ,,
Apples	9,486	3,545	13,031	1,045,369 ,,
Pears	864	166	1,030	101,472 ,,
Quinces	85	15	100	8,620 ,,
Apricots	607	95	702	63,668 ,,
Peaches	643	221	864	67,373 ,,
Nectarines	161	64	225	17,175 ,,
Plums	862	274	1,136	86,593 ,,
Bananas	164	85	249	30,151 ,,
Cherries	28	22	50	46,950 ,,
Almonds	283	74	357	71,805 ,,
Figs	338	60	398	39,375 ,,
Strawberries	33	...	33	51,468 punnets
Passion Fruit	51	...	51	5,804 bushels
Pineapples	10	5	15	9,981 No.
Other Fruit	73	33	106	
Small Fruits	12	...	12	
Totals	16,891	5,250	22,141	

VINEYARDS.

——	Area.	Production.
Table Grapes	1,038	58,393 cwts.
Wine Grapes	1,613	42,564 ,,
Drying Grapes	2,474	195,920 ,,
Not bearing vines	980	..
Total	6,105	296,877

Importation of Fruit Trees and Plants.

Apple trees as usual bulk largely in the returns showing importation of nursery trees from the Eastern States; the number 33,529 being sufficient to plant

out 335 acres, with an additional 20,648 stocks for propagation purposes in the local nurseries. It is interesting to note a new fruit is figuring in our list, and in quite respectable quantities. I refer to the importation of 33,159 tung oil trees. Full particulars are as follow:—

PLANT DISEASES ACT, 1914.

Return of Fruit Trees and Plants Inspected at the Ports of Fremantle and Albany for Year ending 30th June, 1938.

Kind of Trees.	Fremantle.	Albany.	Total.
Apple	26,461	7,068	33,529
Apricot	2,232	99	2,331
Almond	2,525	40	2,565
Cherry	690	65	755
Fig	3	8	11
Lemon	3,487	10	3,497
Loquat	413	3	416
Mulberry	873	3	876
Nectarine	1,427	40	1,467
Mandarin	1,051	...	1,051
Orange	9,233	9	9,242
Grape Fruit	1,035	1	1,036
Peach	6,502	207	6,709
Persimmon	105	2	107
Pear	3,372	132	3,504
Plum	4,738	99	4,837
Quince	62	16	78
Pomegranate	25	...	25
Banana	2	...	2
Walnut	97	9	106
Other Nut	934	...	934
Chestnut	...	1	1
Cumquat	72	...	72
Strawberry	3,908	100	4,008
Raspberry	137	18	155
Currant	201	24	225
Gooseberry	188	6	194
Loganberry	150	12	162
Apple stocks	20,648	...	20,648
Apricot stocks	2,000	...	2,000
Pear stocks	3,000	...	3,000
Peach stocks	3,000	...	3,000
Orange	2,000	...	2,000
Tung Oil plants	33,159	...	33,159
Ornamental	25,974	1,314	27,288
Bulbs and Roots	472,185	...	472,185
Bulb Fibre	21 bags	...	21 bags
Grass Roots	1 bag	...	1 bag
Total	631,889 + 22 bags	9,286	641,175 + 22 bags

In returns showing the importation of fresh fruit from the Eastern States it will be noted that nearly twice as many cases of oranges are brought by the Trans. train to Kalgoorlie than are exported overseas from Western Australia. The quantity, however, 6,549 cases, is not large when one considers that annually upwards of 300,000 cases are produced and consumed locally in Western Australia.

Details are as follow:—

IMPORTATION OF FRESH FRUIT INSPECTED UNDER THE "PLANT DISEASES ACT, 1914," FOR YEAR ENDED 30TH JUNE, 1938.

Kalgoorlie—			
Bananas ...	3,946	crates	
Pineapples ...	82	cases	
Nuts ...	39	bags	
Passion Fruit ...	25½	cases	
Tomatoes ...	287½	"	
Oranges ...	6,549	"	
Mandarins ...	26	"	
Grape Fruit ...	77	"	
Cocoanuts ...	3	"	
Lemons ...	449	"	
Gooseberries ...	53½	"	
Cherries ...	857½	"	
Nectarines ...	759½	"	
Plums ...	1,333	"	
Peaches ...	1,651½	"	
Strawberries ...	6	"	
Loquats ...	7	"	
Apricots ...	157	"	
			16,309 packages.
Fremantle—			
Bananas ...	152	crates	
Pineapples ...	1,421	cases	
Nuts ...	4,684	bags	
Oranges ...	70	cases	
Grape Fruit ...	150	"	
Gooseberries ...	480	"	
Cherries ...	2,331	"	
Nectarines ...	44	"	
Plums ...	79½	"	
Peaches ...	5	"	
Olives ...	2	"	
Cape Gooseberries ...	½	"	
Mangoes ...	3	"	
			9,422 packages.
Albany—			
Bananas ...	32	crates	
Passion Fruit ...	½	case	
Oranges ...	61	cases	
Mandarins ...	4	"	
Grape Fruit ...	7	"	
Gooseberries ...	5	"	
Nectarines ...	4	"	
Peaches ...	1	"	
Loquats ...	1	"	
			115½ packages.
Carnarvon—			
Nil ...	Nil		Nil
	Total ...		25,846½ packages.

Though Western Australia is making a sustained and promising effort to supply her people with bananas there is still considerable leeway to make up, and the importations of fruit from overseas are mainly comprised of bananas. Particulars are as follow:—

IMPORTATION OF FRESH FRUIT UNDER THE QUARANTINE ACT FOR YEAR ENDING 30TH JUNE, 1938.

Bananas ...	4,383,300 lbs.
Mangoes ...	1,100 "
Mangosteens ...	300 "
Pineapples ...	2,100 "
Cocoanuts ...	72,400 "
Nuts ...	128,838 "
Total ...	4,588,038 lbs.

TOBACCO CURING EXPERIMENTS AT MANJIMUP, SEASON 1936-37.

A. SHARP, U.D.A.,
Tobacco Adviser.

INTRODUCTION.

With the object of investigating a number of curing problems which confront tobacco growers, and of trying out a more scientifically designed curing barn than had previously been in use in this State, a curing kiln was erected on the property of Mr. G. F. Combs at Jardee, during the 1936-37 season, and a series of curing experiments was initiated.

The size of the kiln was 10 ft. 6 ins. long, 8 ft. wide and 14 ft. high to the eaves. This height was sufficient to a.low of four tiers of leaf being hung in the barn. The floor area was smaller than the usual commercial barn, but was large enough to ensure that the conditions inside it during the curing process would be similar to those which would obtain in a well-built commercial size kiln.

The framing of the barn consisted of 3 in. x 2 in. jarrah, lined on the outside with corrugated iron and on the inside with asbestos-cement sheets. The space between the linings was filled with jarrah sawdust in order to insu ate the interior from fluctuations of the outside temperature. The roof was of corrugated iron lined inside with asbestos-cement sheets. The top ventilator consisted of an opening 8 inches wide running the whole length of the ridge of the roof. This opening was surmounted by a solidly constructed ridge-piece which could be raised or lowered according to the amount of ventilation required. The bottom ventilation consisted of two galvanised iron pipes sunk in the floor, running directly beneath the heating flues, and connected at either end to the outside air by elbows, the mouths of which could be c'osed or opened to any desired degree by shutters. An opening half an inch wide along these pipes, just under the flues, caused the incoming air to be thoroughly heated before coming in contact with the leaf in the barn. The heating system consisted of a brick firebox outside one corner of the barn, connected to an eleven-inch diameter sheet-iron flue pipe running round three sides of the barn and leading to an exterior chimney.

This barn, when put into operation, gave excellent results and proved to be extremely economical in firewood. The general design has since been copied by a large number of growers and has given general satisfaction. From the point of view of demonstrating the superiority of a scientifically designed kiln over the rather crude type previously in general use in this State, this barn has amply justified itself.

SCHEME OF EXPERIMENTS.

1. The first point on which information was desired was whether the relative humidity of the atmosphere in the curing barn could be kept sufficiently high during the yellowing process without the introduction of steam. Theoretically, the moisture given off by the leaf itself should be sufficient for the purpose, but some experienced curers maintain that the introduction of additional moisture, either in the form of low pressure steam from a boiler or by placing wet bags on the warm flue pipes, is beneficial. On the other hand, the writer's own observations had led to the suspicion that the excessive use of steam was responsib'e for a considerable amount of "sponging" of the leaf during the fixing of the colour.

2. The second point which it was desired to investigate was the relative merits of fast and slow curing. The rate at which the temperature and ventilation of the

barn can be increased during the fixing of the colour is a matter on which some doubt exists. Generally speaking, very slow increase of temperature tends to increase the amount of sponging in the leaf, while some curers maintain that fairly rapid rise of temperature with corresponding increase in the amount of ventilation spoils the texture of the finished product.

Arrangements were made to purchase mature, uncured tobacco leaf from Mr. Combs as required. It is desired here to express appreciation of the assistance which Mr. Combs rendered during the course of the experiments. In all, four barns of leaf were cured during the season, the first two being devoted to investigating problem No. 1, and the others to problem No. 2.

The 1936-37 season was an exceptionally hot and dry one, and as a result, a good deal of damage had been done to tobacco crops generally by scorching, rendering the leaf harsh and more than usually difficult to cure. The leaf purchased from Mr. Combs was of the "Hickory Pryor" variety, of heavy body, and a proportion of it showed signs of scorching owing to the harsh climatic conditions under which it had been grown This damage became progressively worse as the curing season advanced.

The following are the details of the experiments and individual cures:—

Experiment No. 1.

To determine whether the amount of moisture given off by the leaf during the colouring process is sufficient to keep the humidity in the barn sufficiently high to allow this process to proceed normally, or whether the artificial addition of moisture is beneficial.

Cure No. 1.—The leaf was picked from 6 a.m. to 9 a.m. on Tuesday, 2nd February, 1937, strung on the sticks during the day, the barn being filled and the cure started by 5 p.m. The yellowing process was commenced at a temperature of 87 deg. with ventilators closed The temperature was raised very gradually until at 4 p.m. on the following day (Wednesday) it stood at 105 deg. During this time the wet and dry bulb thermometer readings showed a difference of 3 deg., indicating a relative humidity of about 88 per cent., which was maintained without the use of added moisture. By 7 p.m., 26 hours after commencement of the cure, the temperature was 112 deg. dry bulb, with wet bulb 8 deg. lower. At this stage the leaf was a pale pea-green colour, and the top ventilator was opened slightly. From then on the temperature was gradually raised and ventilation increased until at 10 p m. on the following day (Thursday) it stood at 135 deg. with ventilators full open. The web of the leaf was dry by 5 a.m. on Friday and the temperature was then gradually raised to 160 deg. and kept there until 10.30 a.m. on Saturday when the midribs were dry and the cure completed. This cure took 89½ hours to complete. By the following morning the leaf had conditioned sufficiently and was removed from the barn and bulked away.

Cure No. 2.—The leaf was picked on Monday, 8th February, 1937, from 6 a.m. to 9.30 a.m., strung on the sticks during the forenoon, the barn being filled and the cure started by 1.30 p.m. The temperature during yellowing was kept as nearly as possible the same as in the previous cure, but from the beginning of the cure until half an hour after midnight on Wednesday, wet bags were placed on the warm flues in order to obtain as high a degree of humidity as possible. The difference between the wet and dry bulb readings during most of this period was not more than two degrees and was frequently less than one degree, showing practically complete saturation of the atmosphere. *The increased humidity had no effect whatever so far as accelerating the yellowing process was concerned.* The top ventilator was opened slightly at 3 a.m on Wednesday, 37½ hours after commencement of

curing, and from then on the cure followed the same lines as No. 1. The cure was completed at 10.30 p.m. on Friday, 12th February, having taken 105 hours. Owing to the very hot, dry weather prevailing, some difficulty was experienced in getting the leaf to condition sufficiently to bulk, and it was not until Sunday morning that this operation was completed. It will be noted that this cure took 15½ hours longer to complete than did cure No. 1. This was due partly to the fact that yellowing was carried on longer in an endeavour to eliminate more green from the leaf and partly to ensure that a few very thick fleshy midribs were thoroughly dry.

The leaf from these two cures was bulked side by side in a small shed kindly made available by Mr. Combs. The bulks were examined on 14th May during damp weather, and were turned to allow of the absorption of a little extra moisture to facilitate handling during grading.

RESULTS OF EXPERIMENTS 1 AND 2 COMPARED.

The leaf was graded during the first week of July into six grades. The following are the gradings of the two cures:—

	Cure No. 1.		Cure No. 2.	
	Weight in lbs.	% of Total.	Weight in lbs.	% of Total.
Grade 1	8½	4.77	½	0.32
Grade 2	37	20 73	10½	6.78
Grade 3	48	26 89	62	40.00
Grade 4	44	24 65	32	20.64
Grade 5	6	3.36	15	9.68
Grade 6	35	19.60	35	22.58
Total	178½	100.00	155	100.00

Grades 1, 2 and 3 were classed as "Bright Mahogany," Grade 4 as "Inferior Bright," Grade 5 as "Mixed Low Grades," and Grade 6 included all leaf showing the least tinge of green.

A study of the above figures reveals that 25.5 per cent. of the leaf from cure No. 1 was placed in the two top grades as compared with only 7.1 per cent. from cure No. 2. It is difficult to estimate just how much of this loss of brightness in cure No. 2 was due to the method of curing and how much was due to an extra week's exposure of the leaf to the extremely unfavourable weather which was experienced at the time. The result, however, would appear to indicate that the application of artificial means of saturating the atmosphere of the curing barn does not accelerate the yellowing process and does not cause any increase in the proportion of bright leaf. It is quite possible, however, that this conclusion may have to be qualified somewhat, inasmuch as it applies to a curing barn which was carefully built so as to prevent as far as possible the escape of moisture-laden air and its replacement by drier air while the ventilators were closed. It was found that a relative humidity of about 88 per cent. could be maintained without difficulty in the experimental barn during the initial stage of the cure. There is little doubt that comparatively few grower's barns with bag walls would be capable of maintaining such a high degree of humidity without the application of extra moisture. *This experiment has shown,* however, *that a relative humidity of the order of* 88 *per cent. is quite sufficient for normal colouring of the leaf, and that complete saturation of the atmosphere is neither necessary nor desirable.*

Experiment No. 2.

This experiment was designed to determine whether fairly rapid raising of the temperature, together with ample ventilation, during the process of fixing the colour, gives better results than very gradual increase of temperature and ventilation.

Cure No. 3.—The leaf was picked between 6 a.m. and 9 a.m. on Monday, 15th February, 1937, and was strung on the sticks during the day. The barn was filled and curing started by 5 p.m. The yellowing of the leaf was commenced at between 80 and 90 deg., the temperature being gradually raised to 100 deg. in 24 hours. No moisture was added to the barn. The leaf was sufficiently yellowed by 7 p.m. on Tuesday, 26 hours after curing had commenced, and the top and bottom ventilators were then opened very slightly. Temperature was then raised very gradually and ventilation increased very gradually until 5 p.m. on Wednesday, 48 hours after commencement of curing, temperature was 125 deg. and ventilators full open. Slight signs of sponging were observed during this period. The temperature was 135 deg. and the web of the leaf dry at 9 a.m. on Thursday, 64 hours after commencement of curing. Temperature was then raised gradually to 160 deg., at which it was kept until the midribs were dry. The cure was finished at 4.30 p.m. on Friday, the total time taken being 95½ hours. Trouble was again experienced in getting the leaf into condition for bulking, and this was not accomplished until early on Monday morning, 22nd February.

Cure No. 4.—The leaf was picked between 6 a.m. and 9 a.m. on Tuesday, 23rd February, 1937, and was strung on the sticks during the forenoon. The barn was filled and the cure started by 2 p.m. Yellowing was commenced between 80 and 90 deg. as in the previous cure, but was allowed to go farther before ventilation was begun. The ventilators were opened about one quarter full at 3 a.m. on Thursday, 37 hours after curing had commenced, with temperature at 120 deg. Within half an hour ventilators were full open, and by 4.30 a.m. the temperature was up to 126 deg. Temperature was then raised fairly rapidly to 135 deg., and by 6 p.m. on the same day the web was dry, 52 hours after commencement of curing. Temperature was then raised gradually to 160 deg. at which it was kept until the midribs were dry. The cure was completed at 2 p.m. on Saturday, the total time for the cure being 96 hours. The leaf conditioned very slowly and was bulked away the following Monday morning.

RESULTS OF EXPERIMENTS—3 AND 4 COMPARED.

The leaf from cures 3 and 4 was bulked alongside that of cures 1 and 2 and treated in a similar manner. It was graded during the first week of July and the following table shows the result:—

	Cure No. 3.		Cure No. 4.	
——	Weight in lbs.	% of Total.	Weight in lbs.	% of Total.
Grade 1	...	...	...	...
Grade 2	11½	5.74	5½	2.76
Grade 3	31	15.46	34	17.04
Grade 4	92	45.88	81	40.60
Grade 5	4	2.00	18	9.03
Grade 6	62	30.92	61	30.57
Total	200½	100.00	199½	100.00

These grades have the same connotations as in the first two cures.

It will be noted that there is a distinct falling off in the quality of the leaf obtained from these two cures as compared with cures 1 and 2. This was principally due to the seasonal conditions experienced. All growers reported that their leaf became increasingly difficult to cure, and the proportion of "Bright" leaf less, as the season progressed.

It will be seen that cure No. 3 showed a rather higher proportion of bright leaf than No. 4, but it is believed that this was due more to the condition of the leaf when picked than to the difference in the method of curing. *It was evident during the curing that there was more liability to sponging when temperature and ventilation were increased very gradually than when such increase was comparatively rapid.* There is little doubt that this tendency would be more pronounced in the old type of kiln in which no provision is made for preheating the incoming air.

Close examination of the leaf during grading failed to reveal any significant difference in texture between the two cures. *It would appear,* therefore, *that comparatively rapid raising of the temperature during the fixing of the colour, combined with ample ventilation, reduces the risk of sponging without materially affecting the texture of the leaf. It will be observed also that slow fixing of the colour did not reduce the proportion of green leaf.*

It will be noted that the proportion of leaf graded as "Green" appears to be unduly high in all the cures. This was due principally to the standard of grading being much more strict than is usually the case in commercial grading. Every leaf with the slightest tinge of green was placed in this grade although quite a large proportion of it would probably have been saleable. The whole of the leaf in Grade 6 was packed away in a wooden case and will be examined and regraded after twelve months storage.

CARE AND FEEDING OF CHICKENS.

(G. D. SHAW.)

The problems of mating and incubating are so many that they can only be overcome by experience, but the beginner can care for and manage successfully a flock of chickens should he pay strict attention to the details. When we leave the broody hen to hatch and mother the batch of chickens our only problem is to see that the hen and her brood have sufficient food, clean fresh water and plent of grit. These essentials to the successful growth of the stock, should be always handy and the hen can then be left to herself and she will do the rearing with a minimum of labour and worry to the owner. It is when the chickens are hatched in the incubator or are purchased and delivered to the farm that we are likely to meet trouble in the rearing. The transferring from the incubator or the packing boxes to the brooders is a dangerous period in the life of the young chick.

BROODERS.

A brooder is a device by which chickens are reared without the care of hens. They may be of two systems—

(i) Cold brooders.
(ii) Hot brooders.

(i) The cold brooder is so made that it retains the heat of the chick and so keeps the chick warm and comfortable without the aid of artificial heat

(ii) The hot brooder is one which is warmed by the application of heat and does not depend on the animal heat of the chickens in order to give the necessary comfort and warmth.

(i) *Cold Brooding.*—When one intends to cold brood the chickens, care should be taken to see that the chicks are well fluffed out before the transfer from the incubator or the travelling boxes to the brooder. Always purchase a reliable make of brooder. Do not commit the chicks to the mercies of the home-made brooder. One must emphasise that the majority of home-made brooders are the inventions of those who are not cognisant with the requirements of the day-old chick and the use of these makeshifts will entail work and will cause worry and loss of chickens out of all proportion to the value of the fuel that has been saved. If it is the intention to make the cold brooders on the farm, a model of a proved cold brooder should be used as a pattern.

The cold brooder should be designed to make provision for warmth, comfort, ventilation and safety from ground draughts.

(ii) *Hot Brooders.*—There are many systems of hot brooding of chickens.

(a) First we have the small units which are used with success in every district. They may be heated by an oil lamp which heats the air round the lamp and then directs the heated air into the brooder.

(b) Secondly we have the hot water system of brooders. These brooders are on the sectional principle whereby the water is heated and circulated throughout the shed above the chicks. The shed is partitioned off so that the chicks can be kept in small numbers and the ages kept separate. Brooders which are heated by the circulation of hot water may be in small units or they may be continuous in their application. When they are in small units the water is conveyed in pipes over the chicks similar to the hot air, and, when the water cools, it gravitates back to the heater. Hot water brooders have an advantage in that should the lamp be extinguished accidentally the heat of the water will be sufficient to keep the hover warm for a fairly long period and the dangers from chilling are thereby lessened. When the continuous hot water system of brooding is installed the water pipes are run throughout the length of the brooder house and the house is partitioned into the desired sections, each section being operated as a single brooder compartment It has one disadvantage in that the whole system must be heated even if there are only sufficient chicks to fill one compartment.

(c) Thirdly, we have the battery brooder. The battery brooder is so named because the brooder is arranged in batteries or tiers one above the other. Each battery is heated with a single heat unit and is generally fitted with rollers for convenient movement. Owing to the confined nature of the battery large numbers of chickens can be handled in a minimum of space.

This article is to cover the use of the small brooders and for those who favour the rearing of chickens in small numbers. Whilst agreeing that cold brooding is satisfactory in the hands of those who understand the principles, it is nevertheless suggested that greater success and easier management are possible with the use of hot brooding facilities.

Small brooders are satisfactory when one is dealing with a limited number of chickens and one can extend the use of small brooders to meet the demand of many hundreds. One advantage of small units is that the chicks are under closer observation than when they are in large numbers. The satisfactory unit

is about 75 to 80 chicks. These can be contained under the standard 100-chick unit. When purchasing a brooder, estimate the capacity to be 75 per cent. of that advertised. One can place 100 day-old chicks under a hundred brooder, but owing to the quick growth of the chicks, by the time they are three weeks old the brooder is overcrowded.

In all brooders there is a hover and a nursery, although in many cases the nursery is eliminated and the shed in which the brooder is placed is divided into runs which act as a nursery for the young chicks. If the brooders are to be placed outside it is advisable to have the hover and the nursery connected in one unit. Brooders must be well heated, and there should be a perfect union of the heat, top, side, and bottom. Such fusion of heat will be obtained inside a shed having good ventilation, and covered with litter on the floors. Hot-air brooders are operated on the principle that the air is heated by an oil lamp, and is then directed upwards and into the hover on top of the young chicks. It is there diffused and in cooling falls down on the backs of the chickens and so keeps them comfortably warm. *No matter what may be the outside conditions, an efficient brooder will be able to maintain an even heat inside.*

Battery brooding is practised when there are large numbers of chicks to be handled. These brooders are erected in batteries and are so arranged that the upper compartments contain the youngest of the chicks, and as they grow older they are transferred to a lower compartment. They may be heated with either oil or electricity. The housing for battery brooders must be on different lines from that required for the other types. The batteries are generally operated inside and the feeding also must be altered to compensate for the lack of the natural sunlight. Batteries may be used for the starting of the chicks, after which, at about a fortnight or three weeks, they are transferred to other hot brooder facilities or under cold brooder. Batteries may be used to grow the chicks until they are twelve weeks old, although this practice is not advocated here in Western Australia owing to the natural facilities available for the rearing of young stock. This article will not deal with the operation of battery brooding.

Litter.—The brooder floor should be covered with some form of litter. Those who are fortunate to have a supply of clean sand can use it with advantage. The sand over the floor will keep the chickens occupied and the small particles of cracked grain will be buried sufficiently deep to give all the exercise desired. If sand is not available, the use of finely cut straw is advised. One can use chaff, and even the use of old leaves and small cut rushes will be satisfactory. The main essential is to provide a covering for the floor and see that it will not be too deep. ALL LITTER MUST BE DRY. Any possibility of dampness in the litter will be the cause of trouble and should be avoided.

The brooder itself should be placed in a position which keeps it free from the cold ground draughts and in all cases it should be surrounded by a fence made out of wood or iron. A space of about eight inches should be allowed between the fence and the brooder. It is in this space that the chicks are confined for the first three days. Under the brooder there must be some form of litter and the best littler for under the brooder is clean dry sand and chaff. When the chicks are used to the heat and can find their way from the hopper to the brooder, the fence may be enlarged or one side may be taken away and the chicks allowed to roam.

Generally the best means of feeding the chickens will be to have the hopper form one or more sides of the fence until the chicks are trained to know where the heat is. The hopper can then be moved further away and the chicks can then travel from the brooder to the hopper. The remainder of the fence acts as a breakwind against the ground draughts and should be kept in place until the chickens are perching.

Temperature of Brooders.—The proper warmth is of the utmost importance. It is recommended that the temperature should be about 95 degrees, but this may have to be altered to meet the changing atmospheric conditions. It is never advisable to rely on the thermometer. The attitude of the chickens under the brooder is the best guide. The chickens themselves will, by their crowding or otherwise, inform the attendant whether the heat is sufficient or not.

Make the chickens spread out. If there is any tendency to crowding it should be evident that the heat is too low, and, no matter what the thermometer reads, it is essential that more heat should be applied so that the chickens spread away from the source of heat. A common symptom of insufficient heat is the attraction to the chicks of the light of the lamp. Many will mistake this for curiosity, but the real cause will be that the chickens are cold and are crowding the lamp.

Placing the Chicks under the Brooder.—When the chicks arrive, or when they are to be transferred from the incubator to the brooder, great care should be taken that the chickens suffer no chill during the process. See that they settle down quickly. This will inform the attendant that the heat is correct. If they crowd the heat or huddle together, turn up the lamp a little, so that the chicks are forced to spread out. The brooders should be visited about five minutes after the chicks are placed under them and by this time they should be well spaced under the hover and more or less resting. When they are settled down they should be left and not disturbed. Under no consideration should you count the chicks on arrival. This is distinctly dangerous. When one orders day-old chickens from a hatchery one is at least placing confidence in that hatchery to supply good chickens, therefore have confidence that the hatchery will send the correct number. The chickens arrive in a close box which has been filled to crowding, and the heat inside the box is very high. When the box is opened the heat escapes and the cold outside air will strike on the backs of the chickens. If this striking is of long duration (long enough for you to count 100 chicks), those in the box will catch a chill and eventually go sick; therefore, count them several days later instead.

Feeding.—It has often been suggested that the chick, when born, has sufficient food for sustaining life for at least three days after birth (it is this advantage which has made possible the transportation of day old chicks over long distances) and that no food should be given to the chicks until the fourth day. It has now been proved that the chicken can be given food as soon as it can pick and that no harm will come of the practice of feeding chickens as soon as they are placed in the brooder house. Those which have arrived from the hatcheries are at least two days old and should be fed immediately they have settled down under the brooder.

The feeding rations for chicks are many and varied, and it is necessary to give special attention to the brooder reared chicks because they are confined and they must live by their own efforts—there is no "cluck" in a brooder.

During the first few days the chicks must be taught not only where to find the heat, but also to eat and care for themselves.

Before the chicks arrive, care should be taken to see that everything is in readiness for the correct feeding and watering. In approaching the feeding of chickens it may be advisable to explode some of the old-time methods of rearing chickens, the first of which was the feeding of hard boiled eggs to the day olds. This is not only expensive but extremely dangerous, besides which the eggs which were recommended for the chicks were the incubator infertiles. The incubator infertile eggs may or may not be carriers of the dreaded Pullorum Disease.

Chickens should be fed the simplest of wholesome foods. They do not need the additions of spices which are advocated by the proprietors of patent foods. When chickens are reared under natural conditions they are fed in a natural way. They can partake of green feed when they desire. They have access to grains and insects. When we are desirous of rearing as near to nature as is possible we should endeavour to imitate nature in all respects. It is unnatural to confine the chicks within a house having all the sides enclosed. No advantage is gained with such confinement. All rearers of chickens should allow the chickens to have access to mother earth as soon as possible. If the brooder is heated properly, the chickens will be forced to get away from the heat and in doing so they will eventually be noticed to have their heads outside the curtains of the brooder but their bodies inside. We have then a situation which is near to that practised by the hen and her brood. When she sits down the chickens nestle under her and shortly one will notice the heads showing through the feathers of the mother's body; but keeping the body warm where it is wanted (over the lungs) with the head of the chick out and therefore breathing fresh cool air. The same should apply to those chicks which are confined to brooder management. The heat should drive the heads outside the curtains and the body should be inside the brooder.

The chickens should also be allowed to run outside the brooder house in all weathers. Rain will not hurt them providing they have been educated to know where to find the heated brooder. If the chickens get wet they will run under a brooder which will dry them by its own heat. They will not then chill. When the broody hen is wandering with her clutch she will at times be caught in a shower. Her chicks will also get wet, but in this case she will not run for shelter. She will "cluck" and the chicks will come to her and go under her wings. The chicks are wet and yet she sits in the rain and on the wet earth and drys them by applying the heat of her body where it is most required—on the lungs. One never notices many deaths when the hen is rearing a brood out in the open. If, on the other hand, the brooder is kept at medium heat and depends somewhat also on the animal heat of the chick to give comfort, the chick, when it gets wet, will chill before it becomes dry; because the heat of the brooder is insufficient to do the work.

When feeding young chicks you are now advised to forget the old practices of feeding many small meals a day. The old idea was to give plenty of small feeds during the day—to keep the chicks more or less hungry so that they would always be ready for the next meal. You were advised to give many mashes and then top off the day's feeding with cracked grain in the litter for an evening meal. Plenty of work for the attendant and a system which eventually led in making the rearing season one of hard work and impatience, neither of which was good for the well being of the stock. Now-a-days, we can depart from the laborious ways of olden days and make the rearing season easy and pleasurable.

There is no need for the many meals a day which were rationed out by the attendant. One can feed efficiently on dry mash all day and the dry mash can be made to contain all the foods necessary for health and correct growth. One of the most important points to notice when feeding is to see that there is sufficient feeding space so that *all the chicks can feed at one and the same time.*

If you are going to use hoppers you must provide hoppers large enough to allow all the chicks to approach the hopper at the same time. If the hopper, or feeding space, is restricted, it will be found that some of the chickens (the most modest) will be deprived of the necessary food for maximum growth and health. The bullies will always be able to get the titbits and the shy chick is therefore starved of the necessary ingredients for its requirements in building good body and bone formation.

It is advisable to feed the chickens on a dry mash until they are eight weeks old and thereafter they should be fed a wet mash in the morning (the same as fed to the hens) a dry mash in front of them all day long (a mixture for their particular requirements), and to give whole grain at evening followed by chaffed up green feed.

When feeding chickens it must be understood that each respective breed should be fed a ration for that particular breed. Heavy breeds will not do as well on the ration which is efficient for the light breeds. We are getting back to the principles as stated in "How to Feed Your Fowls," pages 465-470, *Journal of Agriculture* XIII. (2nd series), No. 4, December, 1936. It was there stated that we have three different types of fowls used for utility purposes and those three types require three different feeding rations.

The same with the chickens of those three different types. The light breed does not need as much food as the heavy breed and it does not require as much protein and bone forming foods as the heavy breed. The light breed bird is to weigh 4 lbs. at six months and the heavy breed must weigh 5 to 6 lbs. in the same time. They must have not only different quantities but also different foods. It is therefore extremely necessary for all breeds to be reared separately, otherwise maximum rearing results will not be forthcoming.

In practice it has been found that the young chick requires more protein during the first weeks of life than at other periods of its existence. We must therefore make allowance for this requirement.

The foods recommended for the growing chick are bran, wheat meal, pollard, meat meal, buttermilk (dry), skimmed or separated milk, bone meal, oilcake or key meal with or without the addition of cod liver oil or pilchardine.

If maize can be bought at reasonable prices, it can be used to advantage. Unfortunately, maize is not generally used as a chick food in Western Australia. We are dependent on wheat and its byproducts.

Meat meal is the most important ingredient of the feed. In many parts of the wheat belt farmers supplement the feeds with the fresh flesh of rabbits. While it is desirable to use all the foods abounding on the property, it should be understood that the fresh meats are not high enough in their protein content to give satisfaction and the farmer must still feed a percentage of the concentrated meats known as meat meal. When one is fortunate enough to have a supply of fish meal available, use of this ingredient will give advantages which are unavailable in the other protein concentrates, but until fish meal is procurable in this State we must depend on the use of meat meals and dry milk powders.

Milk Powders.—These foods are a source of minerals and protein and should always be incorporated in all rations whether they are for the feeding of chickens or older stock. We have several brands of milk powders and all can be used with satisfaction. Skim milk and liquid butter milk—these two forms of milk are often to be found on the farm and are recommended. Whole milk, on the other hand, is of little use owing to its fat content. The cream should be skimmed or separated from the milk before use.

When we are using liquid milk we must remember that it is so much water and IS NOT A SUBSTITUTE FOR DRY MILK POWDERS OR MEAT MEAL CONCENTRATES.

The use of milk in any form is a definite help in combating some of the most persistent troubles of chicks.

Bone Meal.—This ingredient is necessary for the building of good bone formation and should be included from the first feed until the pullet has completed her growth at about 15 months of age. Recent researches have suggested that the bone

meal need not be included until the chicks are eight weeks old but the practice of including it from the first meal ensures that the chickens can use it if required. Chickens given high percentages of both meat meal and bone meal from the first meal will grow faster during the first four weeks than those which are fed low percentages of these two meals. The rations given below include the meat meal and the bone meal in average proportions.

Oilcake and key meal are the product of the coconut after the oils have been extracted for foods and soaps and are an excellent addition to the rations. The oil cake is pressed and must therefore be soaked before use. It is therefore included in the wet mash only while the key meal being in the form of dry grounds is used in the dry mash Codliver oil and pilchardine are two oils which are recommended when the chickens are reared in confinement or where there is a shortage or absence of green feed. For Battery brooding one or the other must be incorporated in the mash.

As it is the intention to advocate rearing the chickens in the open runs where both sunlight and green feed can be supplied, cod liver oil or pilchardine are not included in the feeds for the chickens.

The following are the mashes recommended for day old chicks until they are eight weeks old:—

For light breeds—

5 parts bran
3 parts wheatmeal
½ part meatmeal
¼ part dried milk powder
¼ part bonemeal
½ part keymeal

or 4 parts bran
4 parts pollard
½ part meatmeal
¼ part dried milk powder
¼ part bonemeal
½ part keymeal

For heavy breed chicks the meat meal and the bone meal should be slightly increased as follows:—

Meatmeat 11/16 parts
Bonemeal 5/16 parts.

For the evening meal, gristed grain is spread amongst the litter. If a large quantity of mash is mixed before the chickens are due to arrive there will be no rush when they do come. The hoppers can be filled from the storage bins and the chicks need little attention in feeding for the first week.

The first meal should consist of dry bran placed on a sheet of paper and the bran should trail towards the hopper. The chicks will follow the trail and will soon find the feed in the hopper, after which they can be left to their own devices. They will not gorge, neither will they starve if there is enough feeding space for *all to feed at one and the same time.*

In the early afternoon they should be given cracked grain in litter which should not be too deep. Greens can be given to them as soon as they will eat of them. The greens should be chopped up very small at first but after the first weeks they will be able to tear apart the greens as supplied to the older fowls.

Fresh water must be before them at all times. Whenever the water runs out take care to see that the chickens have a good crop full of food before the water is renewed. Excess of water on an empty crop will cause internal disorders.

Shell grit and fine grit.—At all times there must be an ample supply of shell grit before the chickens. Some advocate that the fine shell grit be given in the rations, but in this article it is advised to have the fine grit in a trough where the chicks can partake when they desire. The natural instinct of the growing chick will direct it towards the grit if it can obtain the supply at all times. It is not desirous of forcing the grit into the bird when perhaps the chick does not require the supply at that particular moment of feeding.

Apart from the fine shell grit hard flint-like grit is also necessary to the health of the young chick. The fowl has no teeth and the means of grinding the food is by the strong muscles of the gizzard. In order to assist the grinding of the food hard grist is an advantage. Therefore have both shell grit and hard stone or flint grit before the chicks at all times. Keep the chickens growing all the time and any that lag behind *should not be graded* into a younger batch *but should be culled.* Cull from the first day.

Culling.—When the chickens arrive they apparently show few defects. The hatchery has, in good faith, selected the best available as seen at the time of birth, but the short period which may elapse between the selection and the receipt of delivery will have an effect on the chickens. Those which are not too strong will begin to show the faults at about three days. These chickens were never made to live long, but it has been impossible to find them during the first few days. After a few days under the brooder it will be seen that some are not progressing as they should. They will have a round dumpy body and the wings, such as they are, will not be tight against the body; they will have the tendency to hang aimlessly. When their sisters are eating ravenously they will not even pick at the food; all they will do is to rush from one group to another. If picked up and handled they will have an empty crop. These chickens are soon going to die and should be culled as soon as recognised.

As time passes, it will also be noticed that others will lag behind their fellows. These are further culls. If you do rear them to the laying stage, they will never be able to play their proper part. Kill them off as soon as possible.

At about eight weeks old one will notice a distinct difference in the sizes in the flock. Few will be well behind the other chickens in size and activity. They will be slow in feathering, their heads will be elongated, and the eyes will look dull. These also should be culled. The attendant should never hesitate to kill any chick which will not keep pace with the average of the rest of the flock.

Weaning.—When the chicks are growing they will need less heat week by week, but it is dangerous for one to turn out the heat suddenly. Any reduction in heat must be gradual and cover a period of many days.

If one watches closely the behaviour of the chicks under the brooder one will see the tendency to get further and further away from the heat. It will often be noticed that the largest and strongest will be sleeping outside the brooder at about four weeks old. Some will be even perching on the top of the brooder. When this happens the chickens are ready to be taught how to perch.

The brooders should be placed on a slightly raised platform and the chicks made to go under the first night. The lamp should be turned up fairly high, as the air coming from under will cool the brooder considerably. The platform should be made of a slatted floor 3 x 1in. timber spaced at one inch between each piece. This will give an effect similar to perches closely spaced. When the chickens take to the brooder and the slatted platform they should be left undisturbed for two or three days, after which the slats are widened out nightly. The distance between the slats should *never be wide enough* for the chickens to fall

through to the floor. When the chicks take to the top of the brooder for the second time, it is advisable to then place the proper perches above the brooder. It will then be noticed that those chicks which had started to perch on the brooder will take to the perches, and at about five or six weeks the whole of the chickens have left the brooder and are safely on the perches without handling. When the majority have taken to the perches the lights can be extinguished, but do not remove the brooder for a week or more until it is noticed that the chicks are evading the cover of the hover. If the farmer will practise this idea it will be noticed that the chickens are not handled from the time they are placed under the brooder at day old until they are caught for placing in the laying sheds. There may be difficulties in the way of adopting this idea when one has the large colony hover brooders, but the principle can be used just the same. In this case the perches will have to be placed at the back or on the side of the brooder hover and the chicks attracted to the perches by the use of inclined run ways directing them upwards. It should never be necessary for the farmer to handle the chickens on to the perches. If one must resort to handling, one shows some fault in general management which could easily be remedied with a little forethought.

Feathering.—At about six weeks old it will be noticed that the light breeds will be feathering quickly, but the heavy breeds will take a few weeks longer to complete their furnishings. The feeding up to this stage has been dry mash. At eight weeks you are advised to begin with the wet mash feeding in the morning, dry mash all day, and you can begin to give the whole grain at evening, followed by green feed. The feathering of the bird is the best guide to its condition, and incidentally, it is also the best guide in showing you whether you are feeding the proper balance in the rations. The chicken at this stage is a very lively individual and must be using a great proportion of the carbohydrates of the ration for providing the energy used in its activity. You must therefore reduce slightly the proteins, and the simplest way to accomplish this is to reduce the proportions of meat meal in the rations. It is only a slight reduction, but nevertheless it must be reduced. If this is not followed you will shortly find that the chickens are rushing to maturity, having neither size nor stamina. But if the protein is reduced slightly the stock will continue to grow without danger of early maturity and early laying of small eggs. We have a clear guide as to the proper requirements of protein from the beginning of the feathering. If the percentages of protein are correct, the feathers will be very close to the body—called tight feathering. If, on the other hand, the feathers are loose, i.e., they look like a cushion and they lift from the body with the slightest of breezes, it is then evident that the protein is too high and must be reduced at once.

The look of the feathering is the only guide we have which tells us whether the percentage of protein is correct or not. As the feathers are showing up well at about ten weeks, we have an early guide also. But, if we are going to wait until the chick is about four months old, we have delayed too long to correct any fault, and it will be found that the correction, if made, will have little if any effect in resisting early laying.

The protein must be always controlled with the one object in view, and that object is maturity at the correct age. In light breeds the correct age of maturity is approximately 26 weeks, and 28 weeks for the heavy breeds. There is one factor which must be mentioned when we are referring to the age at maturity, and that is the strain. It is no uncommon thing to find that one strain will nature earlier or later than another strain, so that when we are so balancing the feeds to obtain the correct maturing age we are not to be too definite. The condition and the size of the birds must be examined to estimate

whether the strain is of the slightly early maturing or otherwise. It is of course realised that this difference in maturing is not going to be extended over a wide range of weeks. If one feeds a ration which will place bone and condition where it is wanted, and the feathers are tightly clinging to the body, one will automatically rear the stock to lay at the age which is the best for each and every particular strain of birds.

Feeding after Eight Weeks.—When the chicks are finished with the heat and are perching, they may be treated with the same management as given to the rest of the flock. They are to be fed the same wet mash, even to taking it from the common mixing trough. Give them as much wet mash as they will eat but do not leave any lying round for the pullets to play with. After they have been fed the morning mash they can be left to their own desires as to feeding. The dry mash is in front of them all day so if they feel hungry they can obtain their requirements without the bother of separate feeding times. At midday the chickens should be given a supply of chaffed greens. These greens are relished by the chickens and are one of the most important of the foods. They contain vitamins necessary for the welfare of the stock.

The next meal which is given by the attendant will be that of grain. This is given at about 3 to 3.30 p.m. Early evening feeding as this allows the attendant plenty of time to attend to the rest of the flock. After the grain see that the chickens get plenty of chaffed up greens.

Feeding at Sixteen Weeks.—At sixteen weeks the pullets, as they are now called, should look very even in size and type. You should have been culling any that have fallen behind the rest of the flock. The feathering should be "tight." If the feathering is loose you have little chance of remedying early laying, but you can assist in putting on more condition. To place on more condition you must reduce the protein in the rations. You can even go to the extent of withdrawing all the meat meal from the rations until the stock have built up that condition so desired. BUT NEVER REDUCE THE MILK UNDER ANY CONSIDERATION. Milk, whether dry powder, or liquid, is a great conditioner and is not liable to force the chickens to maturity.

As soon as the pullets show their intention of approaching the nests for laying, the ration must be altered to one containing all the ingredients which are necessary for growth, the replacement of new tissue, and the production of plenty of eggs of good size. The pullet is going to grow for another twelve months and you must be prepared to feed for that growth.

Early Laying.—No matter how correctly we may mix our feeds we are going to have some pullets start laying eggs too early. In this case we are not to change the rations of the flock.

When it is suggested that the light breeds should begin laying at about 24 weeks of age, care must be exercised to see that the MAJORITY lay at that time. It is of little use attempting to obtain uniformity in the beginning of the lay. Some birds mature earlier than their sisters and some are sure to take a longer time than the average. What must be understood is the early average of the flock, not that of a few individuals.

If one is confronted with the too early maturity of the flock, it is desirable to so feed the birds that the condition of those laying is not endangered. As the pullet must still keep growing and at the same time lay plenty of eggs the feed must be able to perform those two functions.

DON'T REDUCE THE FEED WHEN YOU HAVE TOO EARLY LAYING. This is distinctly dangerous. The pullet, if it is from high producing stock, must lay when it reaches maturity and if through any misjudgment of feeding the pullet

begins to lay too early, any reduction of food will cause the bird to draw on the body for the materials for the eggs. The eggs must come and they must be made from something. Generally they will get their needs from the food supplied but if that food is altered in any way from the egg forming ration the *pullet will not cease to lay but will weaken her constitution owing to the draw on it for the eggs.*

Do not follow the starvation feeding practices when you are troubled with early laying. What must be done is to try and assist the pullet to meet in every possible way, the demands for eggs and at the same time allow for growth of her body. When troubled with early laying slightly reduce the meat meal and increase the buttermilk. This slight reduction will assist in slowing up the production and the extra buttermilk will give continued growth to the bird. You must never try to stop the early laying. In endeavouring to stop the laying you will cause danger to the flock.

Late Maturity.—On the other hand it is sometimes noticed that the pullets although they seem to have reached maturity and should be laying, are not producing as they should. This time we have an entirely different complexion. The non-laying may be due to too little protein in the feeds. It is not suggested that the rations are deficient in proteins to any great extent but that it is not quite sufficient for the requirements of both body formation and egg laying. When the pullets do not come up to expectations in laying, it is a good plan to increase the proteins as much as 50 per cent. for two or three days and then fall back to the base. After four or five days following the increase in protein it will be possible for some response to be noticed. If the laying increases you may be sure that the rations can be augmented with a little increase in the protein but NOT TO 50 PER CENT. ALL THE TIME. If on the other hand there is no response to the extra protein you may be sure the birds have not yet reached maturity and are not yet ready to begin laying.

The pullets should be carrying a small amount of fat. There should be a thin layer at the rear and it should be possible to keep that layer of fat. But when an excess of fat is showing there is a danger of heavy loss in production.

Feeding from 6 months onwards is dealt with in the article "How to Feed Your Fowls," *Journal of Agriculture of Western Australia,* Vol. XIII. (2nd series), No. 4, December, 1936, pages 465-470.

EROSION AND SOIL CONSERVATION.

By G. V. JACKS and R. O. WHYTE.

(Imperial Bureau of Soil Science Tech. Communication No. 36, 1938, pp. 206, Price 5s.)

During the past five years the question of soil erosion and the need for soil conservation has been constantly before the public through the Press and through scientific and popular literature. Probably the reason for this publicity has been the activity in the United States of America where a combination of circumstances has forced home the seriousness of the problem and the urgent need for combative and conservation measures. The spectacular dust storms of the western prairies left no doubt in the public mind that the dust demon threatened much of their land. A complete organisation was commissioned, and, backed by appropriate legislation and finance, undertook a reconnaissance survey of the nation which proved the situation to be alarming. About one quarter of the arable land

of the Union had been virtually destroyed as far as arable farming was concerned and a large proportion of the remainder, as well as range and forest country, had been severely damaged.

The accurate data obtained in the United States of America and reported all over the world left no doubt that erosion and soil conservation are world problems and engendered a public realisation that immediate action must be taken. This realisation is reflected by the investigations, educative programmes and ameliorative measures which have been initiated all over the civilised world. The review of Jacks and Whyte presents a valuable summary of the situation in most countries of the world and mentions the legislative action and conservation measures taken.

It must not be thought that the problem of soil erosion, or even the use of control measures, is of recent period. Soil erosion, resulting from over cultivation, over grazing, forest burning and destruction of vegetation on the watersheds, is probably of similar antiquity to man. The decline and decay of civilisations may, in many instances, be correlated with soil erosion. For instance, in the Mediterranean region fertile cornfields of 2,000 years ago are now North African deserts, deforestation in the Pyrenees has caused catastrophic erosion and once populous districts of Syria now support only a poor nomadic population. Antioch, a garden city of 400,000 people at the time of Christ, is now a miserable Syrian town of 30,000 inhabitants. There is no evidence of climatic change during this period.

Civilisation has been a contributory cause in many countries. Thus, British administration in Africa and India has largely eliminated tribal wars, the depredations of raiders and wild beasts and has promoted expansion of crops and herds with soil exploitation and consequent denudation.

And control measures are no new things. Between 1861 and 1935 some 317 million francs have been spent in French Territory on the reforestation of over a million acres and, of this amount, 57 million francs have gone into corrective works. Japan is a country of highly erodible soils and topography and torrential rainfall, yet erosion has been effectively held in check by corrective measures regardless of cost. For the past 150 years check dams have been used to supplement the policy of reforestation in the control of floods and erosion. For centuries the danger of national disaster immediately control measures were relaxed has been recognised and an exemplary technique for combating soil erosion under Japanese conditions has been developed by foresters and engineers.

By contrast, the neighbouring nation, China, is an example of the terrible effects of the ravages of incompletely controlled erosion; disastrous floods, famines and desolation. It is probable that Chinese farmers have done more erosion control work over thousands of years than any other people in the world, but there has been no permanence to the results on account of failure to recognise that control work must commence at the eroding sites in the upper watersheds. The policy of *laissez faire* and the farmers' inherent fatalism has resulted in the acceptance of a condition which could have been obviated by national organisation and co-operative effort as exampled by Japan.

The story repeats itself as one reads through the chapters: some countries making a serious attempt at control and others following the policy of *laissez faire*. The secret is early control and prevention rather than cure as the costs of reclamation increase by the square of the initial damage.

L. J. H. TEAKLE,
Plant Nutrition Officer.

THE OFFICIAL PURE BRED DAIRY CATTLE PRODUCTION RECORDING SCHEME, 1937-38.

G. K. BARON-HAY, Superintendent of Dairying, and G. SLATER.

During the twelve months ended 30th June, 1938, 333 cows completed their test under the Official Herd Recording Scheme, the results being shown in Table 3. The number of cows submitted for test was 356, but 23 cows were either sold or withdrawn owing to sickness before having been under test for 150 days and consequently have been omitted from all averages.

The average production of cows which completed their test compared with that for the two previous years is as follows:—

Year.	Average Butter Fat per Cow, without Allowances.
	lbs.
1935–36	297·17
1936–37	300·87
1937–38	298·08

It will be seen that the average production of pure bred cows under test is approximately constant, and it is probable that, by careful management and more attention to culling in some herds, this figure for average production could be increased considerably, as is indicated in Table 1 where the percentage of cows passing the standard for each breed is shown.

TABLE 1.

Breed.	Number of Cows Tested.	Number of Cows passing Standard.	Percentage of Cows passing Standard.
A.I. Shorthorn	159	94	59·1
Guernsey	64	44	68·7
Jersey	110	39	35·6
Total	333	177	53·1

The total number of cows which completed their test and which passed the standards for production was only 53.1 per cent. compared with 63.7 per cent. for the previous year, and it will be noticed from the table that the lower percentage is due to the comparatively poor performance of one breed.

The position which stud breeders fill in the dairying industry is a most important and responsible one, as upon the comparatively few stud herds devolves the responsibility of providing pure bred dairy sires for maintaining and improving the production in commercial herds.

Six years ago the only herds tested were pure bred herds, but, during the last few years, the owners of commercial herds have been afforded the opportunity of testing their cows under the Grade Herd Recording Scheme. The result has been that many of these farmers, by improving their feeding methods and by persistently culling non-producers, have raised the production of their herds to a level which is now comparable with the average of pure bred herds. Such commercial farmers

are faced with the very serious problem of obtaining dairy sires from stud breeders, which at least will not reduce their average production. It, therefore, is incumbent upon stud breeders to adopt those methods which are proving successful in commercial herds for improving the productions of their own cows, these factors being the well-known ones of ample feeding, fodder conservation, and the eradication of low-testing cows. This latter factor is one that is more costly for stud breeders, as such cows may have cost considerable sums to procure, but, unless it is recognised that the only reason for purchasing the stud animal is that it may prove a high producer and, in addition, have the capacity for passing on that characteristic, then there is no justification for maintaining a stud of pure bred animals.

The writer believes that the average low productions of the Jersey breed during the past year was mainly owing to lack of attention and poor management on the part of some owners and not to any "falling off" in the quality of the stock.

TABLE 2.

Class.	A.I. Shorthorn.		Guernsey.		Jersey.		All Breeds.	
	No. of Cows.	Average Butter Fat.	No. of Cows.	Average Butter Fat.	No. of Cows.	Average Butter Fat.	No. of Cows.	Average Butter Fat.
Mature	31	354·25	21	371·13	36	303·24	88	337·41
Senior 4 years ...	16	302·77	4	347·53	8	273 39	28	300·77
Junior 4 ,, ...	14	300·25	4	328·30	11	286·64	29	298·96
Senior 3 ,, ...	13	297·88	9	373·28	8	321 03	30	326·71
Junior 3 ,, ...	24	313·21	5	324·45	11	287·46	40	307 54
Senior 2 ,, ...	8	253·81	4	321·96	12	210·92	24	243·72
Junior 2 ,, ...	53	264·61	17	262·64	24	251·52	94	260·91

Table 2 shows the production of the cows in each class for the three breeds under test, and it will be noticed that it is mainly in the older classes that the failures occurred in the Jersey breed, which is an indication that the average low production was not due to the cows themselves, as these same animals in many instances produced considerably more during the previous one or two lactation periods as younger animals.

The trophy for the Champion Herd Sire, which is awarded each year to the bull whose leading six daughters have produced the greatest quantity of butter fat, was won by the imported Guernsey bull, "Homestead Ace," owned by Mr. A. W. Padbury. The leading six daughters of this bull averaged 498.98 lbs. butter fat with age allowances. These daughters included one junior 2-year-old, two senior 3-year-olds, and three mature cows. This bull has proved probably the most prepotent sire which has headed any stud of this breed in Western Australia.

During the year a new junior 2-year-old State record for all breeds was created by Messrs. D. Bevan & Sons' Australian Illawarra Shorthorn cow, "Glanavon Golden Girl," with a production of 421.13 lbs. butter fat, thus breaking the previous record held by the cow "Leylands' Melba," also owned by Messrs. D. Bevan & Sons, with a production of 418.43 lbs. butter fat.

The Jersey Herd Society's trophy for the highest producing Jersey cow, with allowance for age, was won by Messrs. Robinson Bros.' cow, "Travalgan Lady Mint 4th," with 607.10 lbs. butter fat. The actual production of this cow was 527.91 lbs. butter fat at 3 years 4 months of age.

TABLE III.

COWS WHICH COMPLETED TEST DURING THE 12 MONTHS ENDED 30TH JUNE, 1938.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
COWS UNDER 2½ YEARS—STANDARD 230 LBS. BUTTER-FAT.											
						lb.	lb.	%	lb.		
Glanavon Golden Girl	A.I.S.	....	29-8-34	20-10-36	273	36	11,558	3·60	421·13	D. Bevan & Sons .	Blacklands Jean's Supreme (1871)
Wooroloo Poppy II.	do.	...	4-5-35	2-7-37	273	27	8,796	4·21	370·43	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Walgett Handsome Girl V.	Jersey ...	59902	7-4-35	14-6-37	273	13	7,126	5·12	365·07	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
Radyr Park Dorothy IV. ...	do. ...	....	5-10-35	24-8-37	273	22	7,221	5·02	362·05	L. Temple	Greenmount Graceful Lad (7292)
Denmark Dawn II.	Guernsey ..	5439	21-3-35	5-7-37	273	13	6,159	5·72	355·14	Denmark Research Station	Koojan Golden Prosper (2283)
Greenmount Marinita	Jersey ...	....	29-4-35	20-9-37	273	24	6,590	5·35	352·41	A. J. B. Strempel ..	Bellefaire Bonaparte's Bonetienne (9224)
Wooroloo Dell	A.I.S.	18628	18-10-34	7-2-37	273	26	9,142	3·78	346·30	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Greenmount Gentle Lady ...	Jersey	...	8-8-35	23-7-37	273	15	6,135	5·58	342·50	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Tipperary Maggie IV.	A.I.S.	18330	15-9-35	13-9-37	273	26	8,103	4·21	340·88	W. G. Burges ...	Blacklands Monarch's Commander (1877)
Tipperary Lady May II.	do. ..	18328	8-10-35	29-9-37	273	27	8,226	4 09	336·58	W. G. Burges ...	Blacklands Monarch's Commander (1877)
Claremont Star 14th	do. ...	....	18-5-35	10-9-37	273	18	7,719	4·35	335·48	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Greenmount Golden Wonder ...	Jersey ..	....	28-3-35	26-7-37	273	14 5	6,089	5 41	329·20	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Glanavon Pink Pearl II.	A.I.S. ...	...	3-9-34	19-10-36	273	23	8,229	4·00	326·27	D. Bevan & Sons ..	Blacklands Jean's Supreme (1871)
Walgett Beau's Ruby	Jersey	59900	11-11-34	30-4-37	273	13	5,859	5·56	325·56	C. J. Cunningham ..	Sabina Vale Betty's Beau (10018)
Koojan Ace's Jewel II. ...	Guernsey	5661	4-3-35	28-4-37	273	13·5	6.551	4·92	322·52	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Koojan Ace's Daphne	do. ..	5657	13-8-34	9-10-36	273	22	6,405	5·03	322·39	A. W. Padbury ..	Koojan Ace (2270)
Claremont Treasure 11th ..	A.I.S. ...	..	3-5-35	19-9-37	273	22·5	7,973	3·94	315·28	Claremont Hospital for Insane	Claremont Herdsman (968)
Tipperary Sally	do.	18338	23-4-35	8-5-37	273	19	7,452	4·18	311·14	W. G. Burges ...	Blacklands Monarch's Commander (1877)
Brookfields Lady Lysle ...	Guernsey...	5326	27-7-35	26-8-37	273	16	6,010	5·16	310·17	P. G. Hampshire & Son	Koojan Ace's Majestic (2735)
Tipperary Beauty III.	A.I.S. ...	18315	8-4-35	2-8-37	273	19	7.287	4·22	307·62	W. G Burges ..	Blacklands Monarch's Commander (1877)
Wooroloo Fairy II.	do.	18631	3-12-34	26-2-37	273	21	7,068	4·35	307·45	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Wooroloo Moss Rose IV. ..	do. ...	..	22-4-35	5-10-37	273	16	6,783	4 52	306·62	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Claremont Plum IV.	do. .	..	24-6-35	28-9-37	273	18	7,539	4·06	306·03	Claremont Hospital for Insane	Claremont Herdsman (968)
Wooroloo Joy II.	do .	...	3-8-35	24-8-37	273	19·5	6,854	4·43	303·58	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Wooroloo Lady Betty	do.	18634	3-8-34	21-10-36	273	21	6,993	4·33	303·44	Wooroloo Sanatorium Farm	Parkview Guardian (2557)

Claremont Poppy 6th	do.	....	26-5-34	3-10-36	273	24·5	7,569	3·94	298·00	Claremont Hospital for Insane	Tipperary Daphne's Boy (449)
Tipperary Dove IV.	do.	18323	18-7-35	29-8-37	273	23	6,729	4·37	294·37	W. G. Burges	Blacklands Monarch's Commander (1877)
Claremont Pansy IV.	do.	15969	18-12-34	20-5-37	273	12·5	6,833	4·29	293·73	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Wooroloo Dove III.	do.	...	4-8-35	26-8-37	273	19	6,507	4·41	286·66	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Brookfields Primrose	Guernsey	5331	24-2-35	27-5-37	273	13·5	5,351	5·34	285·79	P. G. Hampshire & Son	Koojan Ace's Majestic (2735)
Yanget Melba	A.I.S.	.	12-5-35	2-10-37	273	17	6,636	4·29	284·55	Wooroloo Sanatorium Farm	Parkview Sunrise (1875)
Westby Carnation	do.	18514	30-5-35	20-9-37	273	21·5	7,430	3·82	284·27	Bayley Bros.	Telyarup Duke (956)
Koojan Ace's Ida	Guernsey	5659	28-9-34	18-11-36	273	11	4,833	5·77	278·94	J. R. Giles	Homestead Ace (imp. U.S.A.) (1631)
Glanavon Tiny	A.I.S.	..	25-9-34	25-11-36	273	10	6,330	4·36	275·97	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Glanavon Venus	do.	....	14-10-34	5-10-36	273	18	6,774	4·10	275·78	D. Bevan & Sons	Parkview Commodore (306)
Denmark Rose Pearl 8th	Guernsey	5450	23-3-35	23-8-37	240	12	4,830	5·76	275·13	Denmark Research Station	Koojan Golden Prosper (2283)
Westby Lupin III.	A.I.S.	18516	31-8-34	21-10-36	273	18	6,744	4·06	273·59	Bayley Bros.	Telyarup Duke (956)
Wooroloo Sunflower	do.	15348	1-8-34	24-10-36	273	18	6,174	4·42	273·44	Wooroloo Sanatorium Farm	Wooroloo Prince (2974)
Wooroloo Doll	do	...	22-4-35	4-7-37	273	15·5	6,317	4·31	272·08	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Claremont Belle 15th	do.	.	1-7-35	9-9-37	273	17	6,726	4·04	271·90	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Walgett Joy Bells	Jersey	59904	19-7-35	10-4-37	273	9·5	4,919	5·52	271·83	C. J. Cunningham	Sabina Vale Betty's Beau (10018)
Muresk Sunshine	Guernsey	6065	13-4-35	10-5-37	273	12·5	4,913	5·53	271·64	J. R. Giles	Muresk Golden Chief (2925)
Glanavon Doris II.	A.I.S.	.	30-8-34	24-9-36	273	11	6,423	4·20	269·89	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Claremont Whitby Maid 21st	do.	15980	16-9-34	30-11-36	273	25	6,735	3·98	267·88	Claremont Hospital for Insane	Claremont Herdsman (968)
The Wold Air Daisy	Jersey	59710	26-4-35	19-6-37	240	10·5	5,400	4·93	266·37	L. C. Field	Grantham Air Prince II. (10657)
Wooroloo Sunshine III.	A.I.S.	18638	3-1-35	1-3-37	273	21	6,168	4·26	262·91	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Claremont Biddy 28th	do.		12-7-35	20-9-37	273	19	6,582	3·97	261·29	Claremont Hospital for Insane	Claremont Herdsman (968)
Grass Vale Lady Fowler 20th	Jersey	..	29-5-35	12-9-37	240	11	5,033	5·15	259·20	R. H. Rose	Spring Park Starbright's Sweet Duke
Claremont Poppy 7th	A.I.S.		12-4-35	16-6-37	273	23	6,774	3·78	256·02	Claremont Hospital for Insane	Claremont Herdsman (968)
Claremont Maggie Morrison 17th	do.		2-9-35	8-9-37	273	21	6,513	3·89	253·16	Claremont Hospital for Insane	Claremont Herdsman (968)
Yanget Florrie	do	18653	18-3-35	7-6-37	273	19	6,234	4·04	251·75	A. E. Grant	Parkview Sunrise (1875)
Colmyn Brown Maggie	Jersey	56859	27-6-35	2-9-37	273	13	5,484	4·58	251·54	C. H. Ironmonger	Colmyn Prince Victor (10492)
Wooroloo Sunflower II.	A.I.S.	18637	3-9-34	30-12-36	273	15	5,820	4·30	250·55	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Colmyn Susan	Jersey	56862	6-4-35	20-8-37	273	13	4,839	5·17	250·45	C. H. Ironmonger	Colmyn Captain Mac (5855)
Muresk Trixie	Guernsey	6067	29-3-35	24-8-37	273	9	4,782	5·18	247·84	Muresk Agricultural College	Muresk Golden Chief (2925)
Wooroloo Primrose	A.I.S.	18635	8-10-34	7-2-37	273	13	5,661	4·35	246·15	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Lansdowne Clarissa	Guernsey	5678	2-9-35	1-7-37	273	13	4,509	5·48	244·73	J. R. Giles	Koojan Ace (2270)
Muresk Tess	do.	6066	15-5-35	6-9-37	273	13	4,991	4·86	242·76	P. G. Hampshire & Son	Muresk Homestead (2075)
Westby Pearl II.	A.I.S.	18518	28-2-35	19-5-37	273	16	6,198	3·88	240·64	Bayley Bros.	Telyarup Duke (956)
Brookfields Mignonette	Guernsey	5329	18-6-35	2-8-37	273	16·5	5,008	4·80	240·25	P. G. Hampshire & Son	Koojan Lord Barclay (1031)
Denmark Rose Ophelia	do.	5448	11-7-35	15-8-37	273	12	4,956	4·83	239·44	Denmark Research Station	Koojan Golden Prosper (2383)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test	Weight of Butter-fat for period.	Owner.	Sire
						lb.	lb.	%	lb.		
Radyr Park Clarionette	Jersey		9-2-36	14-9-37	273	13	4,149	5·74	238·26	L. Temple	Graceful Lad of Greenmount (7292)
Claremont Beauty 11th	A.I.S.	15947	30-6-34	25-11-36	273	14·5	5,534	4·27	236·59	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Wooroloo Kitty III.	do.		9-7-35	14-8-37	273	17	5,511	4·27	235·41	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Claremont Star 13th	do.	15973	25-10-34	14-12-36	273	14	5,517	4·21	232·58	Claremont Hospital for Insane	Wooroloo Persimmon (2972)
Glanavon Sunbeam 6th	do.		8-11-34	18-3-37	273	16	5,658	4·10	232·12	D. Bevan & Sons	Glanavon Nimrod (437)
Claremont Pinafore 4th	do.	15970	23-7-34	25-10-36	273	17·5	5,383	4·22	227·12	Claremont Hospital for Insane	Claremont Herdsman (968)
Radyr Park Dorothy III.	Jersey	59125	15-11-34	11-11-36	273	11	4,218	5·36	226·04	L. Temple	Graceful Lad of Greenmount (7292)
Radyr Park Melody	do.	59126	26-1-35	9-11-36	273	10	3,840	5·88	225·99	L. Temple	Graceful Lad of Greenmount (7292)
Glanavon Pansy II.	A.I.S.		6-11-34	26-11-36	273	16	5,568	4·03	224·66	D. Bevan & Sons	Parkview Commodore (306)
Crantock White Stockings	Jersey	56955	9-4-36	6-6-37	273	11·5	4,018	5·54	221·92	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Moorlands Judy	do.		4-5-35	27-6-37	273	10	4,395	4·97	218·36	Estate late P. Rose	Preston Prospector (11024)
Wooroloo Ruby II.	A.I.S.	18636	22-10-34	21-4-37	273	12	5,091	4·24	215·99	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Muresk Janet	Guernsey	6055	20-5-35	18-8-37	273	7	4,026	5·29	213·04	Muresk Agricultural College	Muresk Homestead (2075)
Moorlands Janet	Jersey		25-3-35	1-9-37	240	11	4,320	4·90	211·20	Estate late P. Rose	Preston Prospector (11024)
Muresk Pearl	Guernsey	6062	11-7-34	11-10-36	240	16	4,403	4·72	208·02	Muresk Agricultural College	Muresk Homestead (2075)
Wooroloo Daphne	A.I.S.	18627	6-2-35	25-2-37	210	17·5	4,575	4·54	207·90	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Rutherwood Rosalyn	Guernsey	6264	18-8-35	15-7-37	273	8·5	3,851	5·31	204·70	Misses E. & I. Rutherford	Denmark Rosa's Prosper (2639)
Denmark Irish Rosette	do.	5442	27-3-35	22-4-37	273	12	3,996	5·06	202·35	Misses E & I. Rutherford	Denmark Damon (2519)
Moorlands Josephine	Jersey		24-5-35	2-8-37	273	10·5	4,037	5·01	202·19	Estate late P. Rose	Preston Prospector (11024)
Crantock Cream Duchess II.	do.		2-8-35	14-10-37	240	9	3,840	5·26	201·93	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Moorlands Juanita	do.		12-4-35	6-7-37	210	12·5	4,320	4·60	198·84	Estate late P. Rose	Preston Prospector (11024)
Wattle Creek Violet	A.I.S.	18479	23-11-34	2-12-36	273	14	5,202	3·80	197·67	E. T. Thatcher	Glanavon Prospero (2118)
Glanavon Esmeralda II.	do.		11-3-35	22-4-37	240	20	5,070	3·80	192·36	D. Bevan & Sons	Parkview Commodore (306)
The Wold Air Queen	Jersey	59711	23-5-35	27-6-37	210	12	4,245	4·53	192·15	L. C. Field	Grantham Air Prince II. (10657)
Claremont Flora II.	A.I.S.	15962	30-8-34	9-10-36	273	11	4,578	4·17	190·84	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Moorlands Jocelyn	Jersey		3-8-35	20-6-37	273	8	3,729	5·05	188·34	Estate late P. Rose	Melrose Liberty (7973)
Claremont Blossom 16th	A.I.S.	15952	26-8-34	7-11-36	273	10	4,103	4·35	178·75	Claremont Hospital for Insane	Claremont Herdsman (968)
Crantock Golden Duchess	Jersey		8-8-35	27-8-37	240	7	3,150	5·64	177·69	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Glanavon Rosalie	A.I.S.		12-2-35	3-5-37	240	19	5,115	3·41	174·70	D Bevan & Sons	Parkview Commodore (307)
Colmyn Maley	Jersey	56861	29-6-35	4-8-37	210	8	3,345	4·71	157·44	C. H. Ironmonger	Colwyn Captain Mac (5855)
Claremont Blossom 17th	A.I.S.	15953	27-9-34	30-11-36	210	7	3,030	4·47	134·34	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Glanavon Ada	do.		10-10-34	8-2-37	150	20	3,450	3·78	130·44	D. Bevan & Sons	Villiers of Darbalara (2386)
Yanget Treasure	do.	18661	12-5-35	5-8-37	273	4	3,620	3·60	130·17	A. E. Grant	Sunrise of Parkview (1875)
Claremont Star 15th	do.		25-5-35	12-9-37	90	27	2,813	4·17	117·40	Claremont Hospital for Insane	Claremont Herdsman (968)
Glanavon Addie II.	do.		1-2-35	19-3-37	120	21	3,000	3·60	107·91	D. Bevan & Sons	Tipperary Lu Lu's Victor (2865)
Juadine Peerless Lily 9th	Jersey		27-9-35	27-12-37	30	24	720	4·70	33·84	Miss L. Hancock	Juadine Sunshine (8212)

COWS 2½ YEARS AND UNDER 3 YEARS—STANDARD 250 LBS. BUTTER-FAT.

Greenmount Titania	Jersey		12-3-35	8-10-37	273	22	6,906	5 80	400 16	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Claremont Cherry 8th	A.I.S.	15954	11-9-34	17-6-37	273	35	9,765	3 73	363 96	Claremont Hospital for Insane	Claremont Herdsman (968)
Brookfields Lady Hope	Guernsey	5325	14-9-34	8-9-37	273	15	6,925	5 23	362 23	P. G. Hampshire & Son	Koojan Lord Barklay (1031)
Brookfields Morden Lady	do.	5330	10-10-34	26-9-37	273	17	5 934	5 68	336 94	P. G. Hampshire & Son	Koojan Lord Barklay (1031)
Brookfields Lady Lynette	do.	5327	21-7-34	23-5-37	273	17	6,186	5 05	311·51	P. G. Hampshire & Son	Koojan Lord Barklay (1031)
Tipperary Amy	A.I.S.	18313	2-4-34	14-12-36	273	20	7,440	4 10	305 09	W G. Burges	Blacklands Monarch's Commander (1877)
Muresk Moss Rose	Guernsey	6060	17-8-34	4-4-37	273	11 5	5,210	5 53	277 18	Muresk Agricultural College	Minnamurra Plaintiff (1318)
Westby Polly III.	A I.S.	18519	4-10-34	18-9-37	273	18 5	6,701	3 98	266 57	Bayley Bros.	Telyarup Duke (956)
Leylands Radium	do	17176	15-3-34	10-11-36	273	17	6,156	4 10	254 32	Prowse Bros.	Widgee Waa Record (848)
The Wold Merry Daisy	Jersey	55528	14-8-34	10-7-37	210	11 5	4,560	5 55	253 09	L. C. Field	Merry King of Greenmount (4306)
Glanavon Carmen	A.I.S.		21-4-34	19-2-37	273	21	5,883	4 00	235 14	D. Bevan and Sons	Glanavon Valiant (438)
Moorlands Italy	Jersey		20-7-34	19-5-37	240	9 5	4,733	4 94	233 93	Estate late P. Rose	Melrose Liberty (7973)
Grass Vale Molly's Nora	do.	57561	9-8-34	8-8-37	273	10	4,512	5 11	230 22	R. H Rose	Banyule Silvermine's Twylish (7600)
Moorlands Iliad	do		12-6-34	23-5-37	240	11	4,125	5 55	228 84	Estate late P. Rose	Melrose Liberty (7973)
Moorlands Isla	do.		25-7-34	16-7-37	273	4 5	4,559	5 02	228 83	Estate late P Rose	Preston Prospector (11024)
Colmyn Pearl	do.	52319	25-11-34	18-6-37	273	7	4,011	5 62	224 78	C. H Ironmonger	Colmyn Captain Mac (5855)
Glanavon Irene	A.I.S.		22-8-34	10-3-37	273	14	5,232	4 27	223 28	D. Bevan & Sons	Blacklands Jean's Supreme (1871)
Tirano Mabel	do.	18341	12-11-34	28-9-37	273	13	4,644	4 24	196 76	A. Della	Bryn-y-mor Charmer (266)
Yanget Royal Lady II.	do.		13-11-34	30-8-37	273	14 5	4,919	3 77	185 35	A. E Grant	Tipperary Topsy's Monarch (2875)
Moorlands Imena	Jersey		1-12-34	6-6-37	180	12	3,030	5 30	166 65	Estate late P. Rose	Melrose Clarion (6931)
Moorlands Idela	do.		14-10-34	3-6-37	240	5	3,585	4 65	165 84	Estate late P. Rose	Preston Prospector (11024)
Sabina Vale Princess	do.	59372	9-9-34	9-6-37	240	5	2,490	6 15	153 15	Sabina Vale Stud Farm	Banyule Ettric (9200)
Crantock Golden Cream	do.	52397	27-6-34	2-3-37	210	11	2,490	6 08	151 40	Mrs. G H. Burnside	Crantock Blonde's Napoleon (8207)
Sabina Vale Orchid	do.		3-9-34	19-6-37	210	6 5	1,815	5 19	94 17	Sabina Vale Stud Farm	Banyule Ettric (9200)
Selsey Wyandotte III.	do.	55215	14-8-34	23-5-37	60	17	1,050	7 86	82 56	Robinson Bros	Brampton Great Boy (imp.) (9137)

COWS 3 YEARS AND UNDER 3½ YEARS—STANDARD 270 LB. BUTTER-FAT.

Leylands Melba	A.I.S	17170	1-9-33	21-11-36	273	46	12,858	4 44	570 46	D. Bevan & Sons	Widgee Waa Record (848)
Travalgan Lady Mint IV.	Jersey	55607	11-4-34	3-8-37	273	26	8,263	6 38	527 91	Robinson Bros.	Banyule Altitude (5793)
Newstead Lovely 20th	A.I.S.	17585	19-2-34	28-2-37	273	25	11,535	4 01	462 13	W. G. Burges	Renown of Newstead (3077)
Koojan Ace's Daphne	Guernsey	5657	13-8-34	3-10-37	273	25	7,725	5 45	420·80	A. W. Padbury	Koojan Ace (2270)
Claremont Clara 7th	A.I S.	15957	1-4-34	4-9-37	273	34	10,227	4 01	410 40	Claremont Hospital for Insane	Tipperary Virginia's Re-echo (970)
Tipperary Beauty II.	A.I S.	18314	8-4-34	20-6-37	273	24	9,447	4 30	406·28	W. G Burges	Blacklands Monarch's Commander (1877)
Wooroloo Dove II.	do	15323	6-5-34	27-9-37	273	28	9,444	4 29	405 44	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Wooroloo Flash	do.	15329	1-3-34	8-6-37	273	19	8,367	4 32	361 86	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Greenmount Sweet Lass	Jersey	44204	14-7-33	3-1-37	273	16 5	6,440	5 51	354 98	A J B Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Selsey Attraction	do	55203	16-7-34	5-9-37	273	18	5,694	6 14	350 09	Robinson Bros	Brampton Great Boy (imp.) (9137)
Greenmount Little Dot	do	57570	26-4-34	15-9-37	273	16	6,522	5 23	340·89	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Lansdowne Joyce	Guernsey	4361	17-3-34	24-4-37	273	19	6,897	4 92	339 74	J. R. Giles	Koojan Ace's Advocate (2272)
Koojan Ace's Algra	do.	4331	22-9-33	17-11-36	273	15	5,340	6 12	326 55	A W. Padbury	Homestead Ace (imp. U.S.A.) (1631)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
						lb.	lb.	%	lb.		
Greenmount Golden Dewdrop	Jersey	57569	7–8–34	26–9–37	273	11·5	5,165	6·16	318·12	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Lansdowne Diana	Guernsey	4358	2–5–34	24–7–37	273	16	6,438	4·89	314·86	J. R. Giles	Koojan Ace's Advocate (2272)
Wooroloo Joy	A.I.S.	15333	10–4–34	11–8–37	273	11·5	6,332	4·94	313·32	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Wooroloo Milkmaid V.	do.	15339	2–1–34	18–3–37	273	17	7,971	3·92	312·53	E. T. Thatcher	Parkview Guardian (2557)
Westby Polly II.	do.	15142	1–12–33	7–5–37	273	19	8,787	3·55	311·66	Bayley Bros.	Telyarup Duke (956)
Glanavon Dahlia II.	do.		10–5–34	26–6–37	273	19	7,197	4·31	310·63	D. Bevan & Sons	Glanavon Nimrod (437)
Claremont Maggie 6th	do.	9933	8–9–33	20–11–36	273	11·5	7,940	3·89	309·03	Claremont Hospital for Insane	Claremont Herdsman (968)
Tipperary Dove	do.	18320	21–4–34	3–6–37	273	21	7,158	4·25	304·13	W. G. Burges	Blacklands Monarch's Commander (1877)
Leylands Champagne's Lovely	do.	12249	5–6–34	22–7–37	273	18	7,772	3·81	296·26	A. E. Grant	Thornleigh Champagne (930)
Tirano Betty	do.		7–10–33	15–1–37	273	23	7,044	4·12	291·56	A. Della	Bryn-y-mor Charmer (266)
Wooroloo Gold	do.	18632	31–1–34	7–4–37	273	11	6,165	4·11	286·60	Wooroloo Sanatorium Farm	Parkview Guardian (2557)
Yanget Duchess II.	do.	15410	10–5–34	16–9–37	273	12	7,559	3·74	282·62	A. E. Grant	Parkview Sunrise (1875)
Wooroloo Eva II.	do.	15327	27–8–33	25–12–36	273	21	6,783	4·00	271·20	Wooroloo Sanatorium Farm	Wooroloo Prince (2974)
Yanget Della II.	do.	15409	3–5–34	11–9–37	273	10·5	6,827	3·88	264·77	A. E. Grant	Parkview Sunrise (1875)
Moorlands Ione	Jersey		27–3–34	14–8–37	240	18	5,963	4·40	262·61	Estate late P. Rose	Melrose Liberty (7973)
Lemon Grove Dora 8th	A.I.S.	17141	12–12–33	18–4–37	273	16	6,423	4·07	260·61	Prowse Bros	Dan of Greyleigh (97)
Leylands Tiny	do.	17181	24–2–34	15–4–37	273	18	6,639	3·85	255·65	Prowse Bros.	Parkview Commodore (306)
Yanget Royal Lady	do.	15417	21–9–33	26–10–36	240	29·5	7,883	3·23	254·70	A. E. Grant	Glanavon Defender (959)
Colmyn Violet	Jersey	52322	6–10–34	8–10–37	273	12·5	4,898	5·16	253·04	C. H. Ironmonger	Colmyn Prince Victor (10492)
Glanavon Sunbeam IV.	A.I.S.	16492	28–9–33	27–2–37	273	11	5,703	4·17	237·85	D. Bevan and Sons	Tipperary Peter Pan (962)
Denmark Dawn	Guernsey	4117	6–3–34	21–6–37	150	26	4,065	5·42	220·32	Denmark Research Station	Koojan Golden Proper (2283)
Moorlands Ina	Jersey	...	18–5–34	27–6–37	273	8	4,599	4·42	214·41	Estate late P. Rose	Preston Prospector (11024)
Crantock Spotted Socks	do.	...	20–9–33	24–12–36	273	8	3,474	5·71	198·30	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Claremont Treasure 8th	A.I.S.	9948	21–8–33	7–12–36	180	8·5	4,980	3·72	185·52	Claremont Hospital for Insane	Tipperary Daphne's Boy (449)
Sabina Vale Lady	Jersey	59371	6–5–34	28–7–37	273	12·5	3,998	4·30	171·89	Sabina Vale Stud Farm	Banyule Ettric (9200)
The Wold Northwood Pride	Jersey	50863	5–5–34	24–5–37	180	10·5	3,615	4·70	169·79	L. C. Field	Lonswood Lord Grey (7291)
Tipperary Victress	A.I.S.	14790	8–7–34	9–8–37	150	25·5	4,860	3·33	161·94	A. E. Grant	Parkview Rosy's Monarch (1681)
Moorlands Ira	Jersey		1–7–34	4–8–37	120	13·5	2,775	4·89	135·75	Estate late P. Rose	Melrose Liberty (7973)
Wooroloo Rose III.	A.I.S.	15344	27–11–33	4–2–37	120	23	2,962	4·58	135·64	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Sabina Vale Silvermine V.	Jersey	..	13–5–34	21–5–37	90	10	1,095	5·19	56·85	Sabina Vale Stud Farm	Banyule Ettric (9200)
COWS 3½ YEARS AND UNDER 4 YEARS—STANDARD 290 LB. BUTTER-FAT.											
Koojan Ace's Jewel	Guernsey	4333	19–2–33	12–2–37	273	25	8,515	5·42	461·60	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Koojan Golden Butterfly	do.	4339	18–4–33	20–1–37	273	28	8,094	5·63	456·06	A. W. Padbury	Koojan Ace (2270)
Koojan Lady Olive	do.	4340	11–2–33	9–2–37	273	25	8,895	4·99	443·55	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)

Walgett Joy	Jersey	51064	8-7-33	3-6-37	273	15	7,335	5·80	425·65	C. J. Cunningham	Mokine Centenary (7595)
Walgett Water Lily	do.	51066	28-8-33	17-4-37	273	20	8,595	4·73	406·84	C. J. Cunningham	Mokine Centenary (7595)
Lansdowne Cream Lass	Guernsey	4354	7-10-33	19-9-37	273	22	6,596	5·87	387·57	J. R. Giles	Koojan Ace's Advocate (2272)
Muresk Damsel	do.	4720	2-11-33	9-5-37	273	18	7,839	4·94	387·45	Muresk Agricultural College	Muresk Homestead (2075)
Lemon Grove Fussy 6th	A.I.S.	17144	10-5-33	2-4-37	273	24	8,847	4·03	357·91	Prowse Bros.	Alue Bank Lady's Gift (760)
Radyr Park Laddies Princess	Jersey	54869	1-8-33	17-6-37	273	14	5,749	5·30	340·82	L. Temple	Greenmount Graceful Lad (7292)
Wooroloo Kitty II.	A.I.S.	15334	23-8-33	19-6-37	273	15	8,265	4·11	339·78	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Illawah Lex III.	do.	11797	15-2-33	26-1-37	273	24	9,282	3·63	336·56	D. Bevan and Sons	Illawah Veteran's Hope (822)
Greyleigh Cinderella 28th	do.	16705	4-7-33	10-6-37	273	19	7,962	4·15	330·28	Prowse Bros	Quenton of Greyleigh (1472)
Lansdowne Bonnie Blossom II.	Guernsey	4351	6-8-33	30-5-37	273	14	6,762	4·86	328·94	J. R. Giles	Koojan Ace's Advocate (2272)
Grass Vale Twylish Eve	Jersey		17-10-33	1-7-37	273	10·5	6,197	5·04	312·39	R. H. Rose	Banyule Silvermine's Twylish (7600)
Glanavon Sunbeam III.	A.I.S.	10929	16-10-32	29-9-36	273	9	6,897	4·50	309·13	D. Bevan and Sons	Glanavon Nimrod (437)
Lansdowne Dorothy	Guernsey	4359	27-7-33	24-6-37	273	15	6,480	4·75	308·00	J. R. Giles	Koojan Ace's Advocate (2272)
Yanget Royal Lady	A.I.S.	15417	21-9-33	20-7-37	273	19·5	8,422	3·63	305·65	A. E. Grant	Glanavon Defender (959)
Denmark Opal	Guernsey	4122	19-9-33	12-9-37	273	15	5,325	5·72	304·45	Denmark Research Station	Koojan Golden Prosper (2283)
Wooroloo Matilda	A.I.S.	15336	2-3-33	4-11-36	273	17	6,651	4·56	303·33	Wooroloo Sanatorium Farm	Tipperary Persimmon (471)
Grass Vale Golden Cream 9th	Jersey		16-8-33	11-8-37	273	11	5,291	5·70	301·78	R. H. Rose	Banyule Silvermine's Twylish (7600)
Glanavon Sylvia	A.I.S.	10930	11-5-33	10-4-37	273	23	7,299	4·12	300·96	D. Bevan and Sons	Glanavon Nimrod (437)
Lemon Grove Buttercup 25th	do.	17136	25-7-33	21-5-37	273	18·5	7,288	4·10	298·97	Prowse Bros.	Alne Bank Lady's Gift (760)
Lemon Grove Gladys 10th	do.	17147	14-8-33	26-5-37	273	21·5	6,995	4·10	286·87	Prowse Bros.	Dan of Greyleigh (97)
Denmark Prosper's Della	Guernsey	4125	19-12-33	12-9-37	273	11	6,078	4·65	282·52	G. Trevor Hill	Koojan Golden Prosper (2283)
Lemon Grove Pride 8th	A.I.S.	17150	20-7-33	16-3-37	273	7	6,831	4·00	273·76	Prowse Bros.	Alne Bank Lady's Gift (760)
Grass Vale Noramine	Jersey	48537	17-11-33	1-9-37	273	10·5	4,982	5·35	267·32	R. H. Rose	Banyule Silvermine's Twylish (7600)
Colmyn Vera	do.	47680	29-9-33	1-8-37	273	9·5	4,264	5·01	263·88	C. H. Ironmonger	Rye Duke of Glen Iris (1994)
Grass Vale Golden Cream 10th	do.	48535	7-10-33	28-8-37	240	12	5,061	4·93	249·56	R. H. Rose	Banyule Silvermine's Twylish (7600)
Glanavon Addie	A.I.S.	16486	25-9-33	14-5-37	273	13	6,189	3·92	242·64	D. Bevan & Sons	Villiers of Darbalara (2386)
Glanavon Daphne	do.	10922	7-8-33	13-2-37	150	25	4,650	4·02	187·20	D. Bevan & Sons	Villiers of Darbalara (2386)
Lemon Grove Gracie 11th	do.	17148	10-8-33	21-4-37	30	24	720	4·30	30·78	Prowse Bros.	Greyleigh Archer (571)

COWS 4 YEARS AND UNDER 4½ YEARS—STANDARD 310 LBS. BUTTER-FAT.

Leylands Topsy	A.I.S.	17182	18-4-33	14-9-37	273	30	11,670	3·74	436·77	D. Bevan & Sons	Parkview Commodore (306)
Koojan Ace's Algra	Guernsey	4331	22-9-33	29-9-37	273	21·5	6,380	6·09	388·34	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Walgett Handsome Girl II.	Jersey	51062	12-11-32	27-4-37	273	14	6,942	5·31	368·84	C. J. Cunningham	Mokine Centenary (7595)
Westby Lupin II	A.I.S.	15139	6-9-33	10-9-37	273	24	9,389	3·89	365·47	Bayley Bros	Telyarup Duke (956)
Westby Ulery	do.	15143	15-6-33	20-8-37	273	12·5	10,358	3·52	364·81	Bayley Bros	Telyarup Duke (956)
Glanavon Dell	do	8507	2-5-32	17-10-36	273	12	8,676	4·20	362·56	D. Bevan & Sons	Villiers of Darbalara (2386)
Denmark Golden Dawn	Guernsey	4118	9-1-33	17-5-37	273	11	5,823	6·06	352·79	Denmark Research Station	Koojan Golden Prosper (2283)
Muresk Olive	do	4730	27-4-33	2-10-37	273	14·5	6,509	5·37	349·57	Muresk Agricultural College	Triumph of Wollongbar (513)
Wooroloo Duchess II.	A.I.S.	15324	15-8-32	18-11-36	240	18	8,610	4·05	348·72	E. T. Thatcher	Triumph of Pine Creek (2515)
Radyr Park Dorothy II.	Jersey	45845	24-7-32	9-11-36	273	12	5,616	5·75	333·25	L. Temple	Graceful Lad of Greenmount (7292)
Sabina Vale Blossom	do	50536	28-11-32	25-3-37	273	13·5	6,186	5·26	325·38	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9491)
Blacklands Fortune 7th	A.I.S.	9316	11-7-32	23-11-36	273	18	7,464	4·19	313·10	W. G. Burges	Orama of Blacklands (1905)
Westby Pearl	do.	15140	19-2-33	2-4-37	273	14·5	7,773	3·87	300·91	Bayley Bros.	Telyarup Duke (956)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days Test.	Weight of Milk last day of Test	Weight of Milk for period.	Average Test	Weight of Butter-fat for period.	Owner.	Sire.
						lb.	lb.	%	lb.		
Glanavon Vida II.	A.I.S.	16495	25-5-33	28-8-37	273	23	7,359	4·09	300·82	E. T. Thatcher	Glanavon Nimrod (437)
Grass Vale Lady Fowler 17th	Jersey	48536	6-5-33	6-7-37	273	10·5	5,965	5·01	300·44	R. H. Rose	Banyule Silvermine's Twylish (7600)
The Wold Starbright Grey II.	do.	46430	17-4-33	25-7-37	210	18·5	7,200	4·17	299·94	L. C. Field	Lonswood Lord Grey (7291)
Greenmount Bonetienne's Twinklette	do.	44202	6-8-33	7-10-37	273	11	5,163	5·76	298·62	A. J. B. Strempel	Bellefaire Bonaparte's Bonetienne (9224)
Glanavon Doris	A.I.S.	10923	1-8-32	5-12-36	240	14	6,480	4·37	283·02	D. Bevan & Sons	Villiers of Darbalara (2386)
The Wold Daisy Grey II.	Jersey	46428	28-3-33	5-6-37	240	13	5,588	5·02	280·71	L. C. Field	Lonswood Lord Grey (7291)
Blacklands Ettie 9th	A.I.S.	9298	24-9-32	25-2-37	273	22	6,846	4·06	278·14	D. Bevan & Sons	Parkview Limelight (370)
Moorlands Havana	Jersey	..	16-5-33	21-6-37	273	7·5	4,433	5·86	259·59	Estate late P. Rose	Melrose Clarion (6931)
Sabina Vale Silvermine III.	do.	50540	25-5-33	28-8-37	273	6	4,173	6·17	257·51	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9491)
Blacklands Sadie 5th	A.I.S.	9391	26-9-32	9-2-37	240	25	6,510	3·79	246·72	D. Bevan & Sons	Blacklands Major (369)
Denmark Prosper's Mona	Guernsey	4126	2-2-33	29-5-37	273	5	5,245	4·41	232·52	Denmark Research Station	Koojan Golden Prosper (2283)
Moorlands Hecla	Jersey	58546	25-6-33	11-7-37	273	8·5	4,061	5·59	227·09	Estate late P. Rose	Melrose Clarion (6931)
Moorlands Happy	do.	54219	30-4-33	22-6-37	210	12·5	3,960	5·09	201·66	Estate late P. Rose	Melrose Liberty (7973)
Yanget Pendant II.	A.I.S.	15415	29-6-33	9-7-37	180	21·5	5,400	3·71	200·37	A. E. Grant	Yanget Lucky Boy (978)
Fairfield Victory's Actress	do.	10721	25-9-32	11-2-37	210	19	5,640	3·49	197·16	D. Bevan & Sons	Daphne's Victory of Hillview (1652)
Blacklands Thelma 7th	do.	9393	3-12-32	9-2-37	240	11	5,340	3·65	194·97	D. Bevan & Sons	Parkview Limelight (370)
Muresk Beauty	Guernsey	4716	21-4-33	22-8-37	60	23	1,665	5·07	84·54	P. G. Hampshire & Son	Minnamurra Plaintiff (1318)
Juadine Sparkle 9th	Jersey	44522	9-9-33	20-11-37	60	20·5	1,380	3·56	49·14	Miss L. Hancock	Juadine Sunshine (8212)
Denmark Pride	Guernsey	4124	16-2-33	9-6-37	30	20·5	615	5·05	31·05	Denmark Research Station	Koojan Golden Prosper (2283)

COWS 4½ YEARS AND UNDER 5 YEARS.—STANDARD 330 LB. BUTTER-FAT.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days Test.	Weight of Milk last day of Test	Weight of Milk for period.	Average Test	Weight of Butter-fat for period.	Owner.	Sire.
Tabbagong Dove 8th	A.I.S.	7511	19-12-31	6-11-36	273	29	10,482	4·22	442·44	W. G. Burges	Parkview Reward II. (260)
Greenmount Charming Queen	Jersey	40099	9-6-32	6-3-37	273	22	7,506	5·82	436·73	A. J. B. Strempel	Grantham Easter King (6510)
Koojan Bonnie Evelyn	Guernsey	3899	7-4-32	20-10-36	273	16·5	6,725	5·98	402·25	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Blacklands Cowslip 6th	A.I.S.	9288	4-12-32	2-8-37	273	18	8,664	4·27	369·97	D. Bevan & Sons	Emperor of Blacklands (947)
Denmark Rosebud	Guernsey	3876	14-3-32	12-10-36	273	17	6,668	5·42	361·38	Denmark Research Station	Wollongbar Macquarie (1244)
					365	17·5	8,233	5·50	452·93		
Walgett Handsome Girl III.	Jersey	51063	12-11-32	16-5-37	273	9	6,612	5·38	355·85	C. J. Cunningham	Mokine Centenary (7595)
Glanavon Sunbeam III.	A.I.S.	10929	16-10-32	8-9-37	273	14	7,572	4·45	336·76	D. Bevan & Sons	Glanavon Nimrod (437)
Blacklands Fairy 12th	do.	9302	6-5-32	11-4-37	273	13	8,199	4·00	328·01	D. Bevan & Sons	Orama of Blacklands (1905)
Sabina Vale Pansy	Jersey	55176	23-11-32	22-7-37	273	15·5	6,107	5·32	324·68	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9491)
Blacklands Buttercup 6th	A.I.S.	9282	6-11-32	15-5-37	273	16	6,888	4·65	320·00	D. Bevan & Sons	Orama of Blacklands (1905)
Muresk Lady Fair	Guernsey	4729	20-9-32	4-5-37	273	13·5	6,341	4·96	314·73	Muresk Agricultural College	Triumph of Wollongbar (513)
Numbawana Blossom	A.I.S.	17613	2-9-32	10-5-37	273	19	7,902	3·95	312·23	Prowse Bros.	Numbawana Flashlight (144)
Denmark Prosper's Rosa	Guernsey	4127	27-12-32	5-7-37	273	7	5,871	5·31	311·77	Denmark Research Station	Koojan Golden Prosper (2283)
Blacklands Daphne 6th	A.I.S.	9290	2-11-32	19-7-37	273	8·5	9,086	3·39	305·64	A. E. Grant	Fussy's Monarch of Hillview (493)
Blacklands Daphne 7th	do.	9291	18-10-32	21-4-37	273	17·5	7,846	3·58	303·36	A. E. Grant	Fussy's Monarch of Hillview (493)

Blacklands Lady Thelma 7th	A.I.S.	9342	1-11-32	31-8-37	273	19·5	6,944	4·21	292·07	A. E. Grant	Parkview Limelight (370)
Blacklands Myrtle 8th	do.	9369	3-9-32	30-4-37	273	5	6,990	4 17	292·01	A. E Grant	Parkview Limelight (370)
Blacklands Red Queen 8th	do.	9386	16-10-32	30-7-37	273	5 5	8,357	3 38	282·98	A. E. Grant	Orama of Blacklands (1905)
Wooroloo Wing Wing III.	do.	7748	11-5-32	9-12-36	210	18	6,195	4 34	267 63	Wooroloo Sanitorium Farm	Triumph of Pine Creek (2515)
Sabina Vale Ruby's Lass	Jersey		5-4-32	8-12-36	273	14	4,752	5 62	267 29	Sabina Vale Stud Farm	Clarendon Eyre Ruby's Beau (7963)
Blacklands Florrie 14th	A.I.S.	9307	12-4-32	24-2-37	240	15	5,280	5·06	267·18	D. Bevan & Sons	Orama of Blacklands (1905)
Crantock Starbright's Napoleon-ette	Jersey	52400	27-11-32	17-8-37	273	7	5,241	5 01	262 40	Mrs. G. H. Burnside	Crantock Blonde's Napoleon (8207)
Blacklands Rosette II.	A.I.S.	9389	4-5-32	28-4-37	240	12	6,480	3·98	258·18	D Bevan & Sons	Blacklands Major (369)
Numbawarra Silky III.	do.	17626	28-8-32	6-4-37	273	18	6,814	3·63	247 70	Prowse Bros	Jellicoe of Fairfield (1136)
Moorlands Glide	Jersey	45237	5-8-32	16-7-37	180	15	4,875	4 69	223 71	Estate late P Rose	Melrose Clarion (6931)
Blacklands Poppy 5th	A.I.S.	9372	13-10-32	29-8-37	180	20	5,760	3 70	213 12	D Bevan & Sons	Blacklands Major (369)
Sabina Vale Silvermine II	Jersey	55177	29-9-32	28-4-37	273	10	4,170	4·64	193 56	Sabina Vale Stud Farm	Banyule Ettric (9200)
Koojan Pretty Polly	Guernsey	4341	19-9-32	12-2-37	120	30	3,750	4·49	168 54	J R Giles	Homestead Ace (imp. U.S.A.) (1631)
Moorlands Guitar	Jersey	49634	17-7-32	1-5-37	150	8	2,370	5 40	127 89	Estate late P Rose	Melrose Liberty (7973)
Mokine Sapphire II	do	49584	20-10-32	10-10-37	90	21·5	2,295	5·09	117 00	Miss L. Hancock	Juardine Sunshine (8212)
Colmyn Eileen	Jersey		8-10-32	2-9-37	60	39	2,340	3 60	84 24	C H Ironmonger	Rye Duke of Glen Iris (1994)
Mokine Heroine 7th	do.	49583	22-11-32	4-10-37	60	28	1,680	5 00	84 00	Miss L. Hancock	Juadine Sunshine (8212)

COWS 5 YEARS AND OVER—STANDARD 350LB. BUTTER-FAT.

Koojan Bo-peep	Guernsey	3542	26-2-31	2-4-37	273	32 5	10,089	5·59	562·03	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
					365	29	13,015	5 72	744 02		
Koojan Ace's Mignonette	do.	3898	23-4-32	29-7-37	273	27·5	9,023	5 93	534 69	A. W. Padbury	Homestead Ace (imp. U.S.A.) (1631)
Westby Lupin	A.I.S.	15138	28-3-32	1-8-37	273	24 5	13909.	3 71	515 45	Bayley Bros.	Telyarup Duke (956)
Nancy 9th of Raleigh	do.	17519	30-4-27	7-9-37	273	32	10,436	4 87	508 50	D. Bevan & Sons	Union Jack of Raleigh (2375)
Newry Lady Freda	Guernsey	2719	13-9-28	12-5-37	273	20 5	9,272	5 41	501 86	P. G. Hampshire & Son	Koojan Mac (596)
Grass Vale Lily's Pride	Jersey	28228	10-2-29	24-4-37	273	14·5	9,284	5 29	490 96	C. J. Cunningham	Starbright's Sweet Duke of Glen Iris (3710)
Karawarra Plum III.	A.I.S	1261	27-4-28	27-8-37	273	39	12,837	3 44	476·01	W. G Burges	Sailor of Karrawarra (Vol. 8)
Wooroloo Jean	do.	5221	15-7-30	2-8-37	273	27	11,181	4 14	462·57	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Blacklands Beauty 10th	do	9279	2-4-32	26-6-37	273	27	10,686	4 30	460 24	W. G. Burges	Fussy's Monarch of Hillview (493)
Koojan Bonnie Evelyn	Guernsey	3899	7-4-32	25-9-37	273	17	7,746	5 89	456 45	A. W Padbury	Homestead Ace (imp. U.S.A.) (1631)
Wingeewah Melba	A.I.S	6732	22-4-31	15-10-36	273	36	11,718	3 84	449·65	A Della	Regent of The Hill (3038)
Radyr Park Dorothy	Jersey	45844	27-7-31	12-9-37	273	16	8,793	5 08	446·92	L. Temple	Melrose Clarion (6931)
Beauna Vista Fairy 5th	A.I S.	1322	8-12-29	9-10-36	273	27 5	105.38	4 15	437 44	Prowse Bros.	Spearfelt of Alne Bank (1029)
Greenmount Starbright Marmora	Jersey	34841	31-5-30	24-3-37	273	19	7,769	5 53	429 39	A. J. B. Strempel	Werribee Starbright's King (2602)
New Park Sally 9th	A.I.S.	1873	30-4-29	8-5-37	240	21	11,835	3·63	429 12	W G. Burges	Ruler of Greyleigh (1855)
Wyuna Lady Dawn	Guernsey	2472	12-11-29	14-5-37	273	12	8,796	4 83	425 48	Denmark Research Station	Nundorah Prosper (664)
Wingeewah Kate III	A.I S.	1535	20-3-29	3-11-36	273	37	10.791	3 94	424 11	A. Della	Daphne's Defiance of Hillview (Vol. 8)
Walgett Handsome Girl	Jersey	42402	1-12-31	19-4-37	273	14	7,377	5 65	416 58	C. J Cunningham	Burekup Campanile's Duke (7287)
Koojan Morden Lady IV.	Guernsey	1901	23-9-26	20-9-37	273	19	7,617	5 45	415·11	J. R. Giles	Robin of Nundorah (417)
Banyule Silvermine 66th	Jersey	28847	10-9-29	2-4-37	273	22	8 189	5 04	412 37	Sabina Vale Stud Farm	Milkmaid's Chief of Banyule (1412)
The Wold Starbright Daisy	do.	31179	8-7-30	31-5-37	240	16	7.282	5 62	408 98	L C Field	Grantham Starbright's King (5796)
Walgett Fortune	do	42401	10-11-30	20-4-37	273	15	8,100	5 03	407·19	C. J Cunningham	The Valley Twylish Fox (5623)
The Pines Bell	A.I S.	4079	6-9-30	27-8-37	273	26	8,603	4 58	394 51	E. T Thatcher	Democrat of Alne Bank (1625)
Wingeewah Silver III.	do	1547	4-10-28	2-5-37	273	19	9,462	4 15	392 48	A Della	Karawarra Werri (2759)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
						lb.	lb	%	lb.		
The Wold Daisy Northwood	Jersey	25064	11-7-28	19-5-37	273	11	6,798	5·61	381·24	L. C. Field	Grass Vale Northwood King (5620)
Swanlea Lovely 7th	A.I.S.	4284	12-2-31	23-4-37	273	12	10,491	3·58	376·07	A. E. Grant	Headlight of Parkview (1406)
Koojan Dame	Guernsey	1252	18-6-24	30-10-36	273	25	9,885	3·78	373·10	Denmark Research Station	Robin of Nundorah (417)
Harridale Girlie	do.	3820	24-9-30	28-9-37	273	16	7,855	4·74	372·72	P. G. Hampshire & Son	Minnamurra Rose Chief (1016)
Springmead Josephine	Jersey	42003	10-6-31	10-8-37	273	15	5,940	6·09	361·71	Robinson Bros.	Bellefaire Blonde's Corsican (7040)
Radyr Park Laddie's Estrellita	Jersey	45846	16-7-32	1-8-37	273	9	6,456	5·61	361·61	L. Temple	Graceful Lad of Greenmount (7292)
Claremont Laura III.	A.I.S.	8328	26-4-31	9-4-37	273	17	9,441	3·83	361·57	Claremont Hospital for Insane	Claremont Elector (446)
Muresk Rose	Guernsey	2156	9-5-28	7-8-37	240	17	7,515	4·76	357·82	Muresk Agricultural College	Triumph of Wollongbar
Beauna Vista Tiny 18th	A.I.S.	4221	24-6-30	18-6-37	273	23·5	9,461	3·73	353·22	Prowse Bros.	Spearfelt of Alne Bank (1029)
Kudardup Pansy	Guernsey	2927	16-1-31	30-4-37	273	12	5,996	5·87	352·22	J. R. Giles	Newry Golden Prince (977)
Moorlands Dot	Jersey	31236	16-5-29	22-6-37	273	16	6,813	5·12	349·07	L. Temple	Melrose Romeo (5861)
Claremont Maggie Morrison 9th	A.I.S.	8329	12-11-30	12-11-36	273	11	9,768	3·56	347·71	Claremont Hospital for Insane	Claremont Elector (446)
Greenmount Marinette	Jersey	34840	24-5-31	19-9-37	273	19	6,972	4·95	346·26	A. J. B. Strempel	Grantham Starbright's King (5796)
Grantham Lady Fowler V.	do.	28231	17-5-29	24-6-37	273	13	6,249	5·53	345·82	L. Temple	Grantham Starbright's King (5796)
Sabina Vale Countess	do.	55175	27-4-32	9-8-37	273	12·5	5,858	5·84	342·34	Sabina Vale Stud Farm	Bellefaire Seaborn Successor (6824)
Denmark Prosper's Dinah	Guernsey	3272	7-12-31	15-6-37	273	6·5	6,214	5·52	341·93	Denmark Research Station	Koojan Golden Prosper (2283)
Denmark Prosper's Lady	do.	3273	6-12-31	9-8-37	273	12	5,916	5·77	341·41	Denmark Research Station	Koojan Golden Prosper (2283)
Clarendon Eyre Betty	Jersey	39244	28-4-28	3-6-37	273	21·5	8,855	3·82	338·28	Sabina Vale Stud Farm	Clarendon Eyre Eminent's Achievement (4154)
Denmark Rosa	Guernsey	1429	15-12-25	26-8-37	273	10·5	6,662	5·03	335·27	Misses E. and I. Rutherford	Rose Chief of Wollongbar (130)
Denmark Rosa III.	do.	2523	5-4-29	8-11-36	273	19·5	6,913	4·82	333·55	Denmark Research Station	Wollongbar Reformer (538)
Grangelea Buttercup	Jersey	26388	21-3-27	28-7-37	273	16	6,648	4·99	331·81	Sabina Vale Stud Farm	Grangelea Daisy's V.C. (5079)
Berrington Soprano II.	do.	28851	5-10-29	16-8-37	273	18	6,916	4·79	331·10	Sabina Vale Stud Farm	Banyule Superstrain (4529)
Radyr Park Dorothy	do.	45844	26-7-31	6-10-36	273	11	6,693	4·84	325·79	L. Temple	Melrose Clarion (6931)
Denmark Rose Dame II.	Guernsey	3280	18-7-31	23-7-37	273	15	6,735	4·79	322·78	G. Trevor Hill	Wollongbar Reformer (538)
Wingeewah Winnie 7th	A.I.S.	4395	20-3-30	27-7-37	273	8·5	9,244	3·49	322·82	A. E. Grant	Daphne's Defiance of Hillview (Vol. 8)
Glanavon Mignon	do.	5109	22-7-31	23-7-37	273	14	7,872	4·09	321·71	E. T. Thatcher	Villiers of Darbalara (2386)
Yanget Pansy II.	do.	8337	10-8-31	4-5-37	273	22	7,476	4·25	318·01	Prowse Bros.	Yanget Pet's Re-echo (452)
The Wold Northwood Grey	Jersey	42214	15-5-32	4-6-37	240	12	6,158	5·16	317·90	L. C. Field	Lonswood Lord Grey (7291)
Glanavon Gold	A.I.S.	10925	25-6-32	1-8-37	273	15	7,800	4·06	317·25	D. Bevan & Sons	Villiers of Darbalara (2386)
Tirano Charming Dinah	do.		28-6-32	8-10-37	273	25	8,325	3·75	312·56	A. Della	Bryn-y-mor Charmer (266)
Blacklands Miss Tottie IV.	do.	9365	12-4-32	25-9-37	273	18	7,569	4·01	303·73	A. E. Grant	Orama of Blacklands (1905)
Glanavon Greta	do.	5188	14-7-31	1-1-37	273	23	7,350	4·09	300·78	D. Bevan & Sons	Villiers of Darbalara (2386)
Hillview Fussy 34th	do.	4496	3-9-30	13-11-36	273	28·5	8,456	3·52	297·96	A. E. Grant	Limelight of Hillview (954)
Denmark Golden Marie	Guernsey	3873	26-4-32	15-8-37	273	13	5,319	5·55	295·35	Denmark Research Station	Koojan Golden Prosper (2283)
Blacklands Modesty III.	A.I.S.	9367	20-5-32	25-8-37	273	21	8,253	3·57	294·87	A. E. Grant	Emperor of Blacklands (947)
The Wold Starbright Grey	Jersey	42215	9-5-32	16-5-37	273	8	5,814	5·04	292·83	L. C. Field	Lonswood Lord Grey (7291)

Denmark Rose Dame	Guernsey ...	1794	19–8–27	19–7–37	240	4	6,615	4·26	281·58	Denmark Research Station	Rose Chief of Wollongbar (130)
Denmark Annabel	do.	3264	17–6–31	14–7–37	273	10	4,943	5·68	280·85	Denmark Research Station	Wollongbar Reformer (538)
Tabbagong Beauty 19th ...	A.I.S. .	7502	20–12–31	6–4–37	273	7	7,236	3·88	280·58	A. E. Grant . .	Parkview Reward II. (260)
Grass Vale Lady Fowler 16th ...	Jersey	44183	2–9–32	5–9–37	273	13	5,244	5·34	280·16	R. H. Rose .	Banyule Silvermine's Twylish (7600)
Swanlea Radium 8th	A.I.S. ..	4990	17–7–31	12–4–37	273	24	7,197	3·87	278·77	Prowse Bros.	Headlight of Parkview (1406)
Kudardup Lillie	Guernsey .	2369	28–6–29	1–7–37	240	12	5,460	4·97	271·19	J. R. Giles ..	Wollongbar Associate (531)
Blacklands Graceful 7th ..	A.I.S.	9318	24–7–32	4–8–37	273	9·5	7,184	3·80	268·22	A. E. Grant .	Orama of Blacklands (1905)
Crantock Lady Bluebell .	Jersey	34724	26–5–29	5–8–37	273	6·5	4,595	5·83	268·16	Mrs. G. H. Burnside	Crantock Starbright's Chief (5790)
Blacklands Florrie 13th ...	A.I.S. ...	9306	3–12–31	24–4–37	273	14·5	6,989	3·83	267·55	A. E. Grant	Orama of Blacklands (1905)
Grass Vale Daisy II.	Jersey .	23654	28–8–26	9–7–37	210	12·5	5,640	4·70	265·35	L. C. Field	Carnation's Masterpiece of Garden Hill (2065)
Tirano Princess	A.I.S.	7677	22–12–30	4–10–37	210	19	6,435	4·09	263·55	A. Della . .	Pine Creek Banker (450)
Banyule Silvermine 59th ...	Jersey	29033	10–2–29	8–1–37	273	19·5	6,239	4·11	256·40	Sabina Vale Stud Farm	Banyule Superstrain (4529)
Banyule Velveteen 12th	do. .	24474	11–9–27	17–5–37	273	11	5,388	4·62	248·97	Sabina Vale Stud Farm	Wotton Airman (imp.) (2716)
Sabina Vale Lotus	do.	46111	16–1–32	15–7–37	240	12·5	5,112	4·60	235·14	Sabina Vale Stud Farm	Banyule Airo (5751)
Sabina Vale Silvermine	do. ...	50539	29–3–32	4–5–37	273	12	4,671	4·92	230·12	Sabina Vale Stud Farm	Banyule Lord Silvair (5752)
Grass Vale Golden Cream 6th....	do. ..	40079	14–8–31	9–6–37	210	12·5	4,770	4·81	229·53	R. H. Rose	Campanile's Duke of Burekup (7287)
Koojan Daffodil	Guernsey....	2231	4–10–28	17–7–37	273	10·5	4,383	5·21	228·38	Misses E. and I. Rutherford	Koojan Golden Governor (595)
Salem View Queen	A.I.S.	17999	17–12–31	26–6–37	180	23	5,595	4·04	226·62	Prowse Bros.	Fairfield Marmaduke (791)
Crantock Lady Buttercup . .	Jersey . .	39439	21–5–30	21–9–36	273	10	3,934	5·71	224·79	Mrs. G. H. Burnside	Crantock Starbright's Montrose (5945)
Moorlands Bridget	do. . .	24920	1–6–27	10–4–37	240	11·5	4,635	4·81	222·81	Estate late P. Rose ..	Colonel of Melrose (4015)
Claremont Dover 7th	A.I.S. . .	8327	24–5–31	7–3–37	180	18	5,340	4·08	217·98	Claremont Hospital for Insane	Searchlight of Sunny Vale (2302)
Moorlands Evelyn .. .	Jersey ...	34811	28–8–30	2–4–37	150	24	4,395	4·91	215·85	Estate late P. Rose ...	Moorlands Romeo (5861)
Moorlands Aline	do. ..	23683	16–7–26	25–7–37	273	10·5	5,432	3·96	215·18	Estate late P. Rose ...	Colonel of Melrose (4015)
Grass Vale Golden Cream 7th. .	do. .	44182	19–7–32	1–8–37	210	9	4,230	4·93	208·64	R. H. Rose . .	Banyule Silvermine's Twylish (7600)
Woodstock Lady Morden ...	Guernsey	3328	27–11–30	30–9–37	150	16	4,470	4·63	206·73	J. R. Giles	Homestead Ace (imp. U.S.A.) (1631)
Denmark Rose Pearl V. ...	do.	3281	20–8–30	30–7–37	120	29	3,720	5·49	204·36	Denmark Research Station	Reformer of Wollongbar (538)
Moorlands Ethel	Jersey	34808	2–4–30	12–4–37	210	6	3,720	5·31	197·55	Estate late P. Rose .	Melrose Raleigh (5860)
Moorlands Clara	do. . .	28215	18–8–28	22–6–37	210	4	4,665	4·19	195·87	Estate late P. Rose	Grafter of Melrose (3560)
Moorlands Fanny . .	do.	41097	7–6–31	4–5–37	210	7	3,713	5·02	186·37	Estate late P. Rose ...	Melrose Raleigh (5860)
Koojan Bonnie Jean . ..	Guernsey..	1612	28–3–26	14–7–37	90	31	3,525	5·11	180·00	A. W. Padbury .	Robin of Nundorah (417)
Travalgan Lady Mint	Jersey ...	34789	21–6–30	24–6–37	90	33	3,060	5·73	175·41	Robinson Bros. .	Tessie's Masterpiece of Garden Hill (6506)
Denmark Prosper's Velvet	Guernsey	3875	23–3–32	12–7–37	120	23·5	3,248	5·04	163·79	Denmark Research Station	Koojan Golden Prosper (2283)
Moorlands Grace . .	Jersey .	45241	3–5–32	3–5–37	120	12	2,265	5·72	129·69	Estate late P. Rose	Melrose Sultan (6930)
Greenmount Charming Queen .	do. ..	40099	9–6–32	16–3–38	30	22·5	675	4·80	32·43	A. J. B. Strempel ..	Grantham Easter King (6510)
Denmark Anne	Guernsey.	1164	2–3–25	4–7–37	30	19	570	4·54	25·89	Denmark Research Station	Linwood of Wollongbar (381)
Moorlands Ella ..	Jersey .	34802	5–5–30	5–8–37	30	20·5	615	4·10	25·17	Estate late P. Rose .	Melrose Romeo (5861)

THE RELATIONSHIP BETWEEN THE HYDROGEN-ION CONCENTRATION, THE FLAVOUR, AND THE KEEPING QUALITY OF BUTTER.

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During the last butter-storage season an investigation was carried out by the officers of the Dairy Branch of the Department of Agriculture, to determine whether any correlation exists between the pH values and the keeping qualities of Western Australian salted butters. This paper presents the results thus obtained, and shows that a high correlation does exist between the pH values and the keeping qualities, and further, that a knowledge of the pH value should be a good criterion by which to judge the suitability of a batch of butter for storage purposes.

The samples were graded before and after storage by official graders of the Department of Agriculture, Messrs. P. C. Cousins and R. A. Paul. The chemical investigations were carried out by the writer.

HYDROGEN-ION CONCENTRATION AND pH VALUE.

To convey to the non-technical reader the meaning of the above two terms, based as they are upon modern physico-chemical principles, is very difficult, but it is hoped that the following notes may assist in giving a general idea of their significance.

Hydrogen gas normally contains a number of electrical charges on each component atom. However, as there is an equal number of positive and negative charges on each atom, the atoms as a whole remain neutral.

If a specially prepared length of platinum wire is dipped into a solution and a stream of hydrogen gas is then made to bubble over it, some of the gas will part with some of its normal inherent electrical charges which will be taken up by the platinum, the gas then passing into solution with an electrical charge of opposite sign to that which it has given to the platinum wire. The electrically charged hydrogen atoms which thus collect in the solution are known as the hydrogen ions. It will thus be seen that the solution acquires an opposite charge to the platinum wire, that is, an electrical potential is set up. By suitable arrangements this potential may be measured in terms of volts. The process may be visualised somewhat as shown in the diagram.

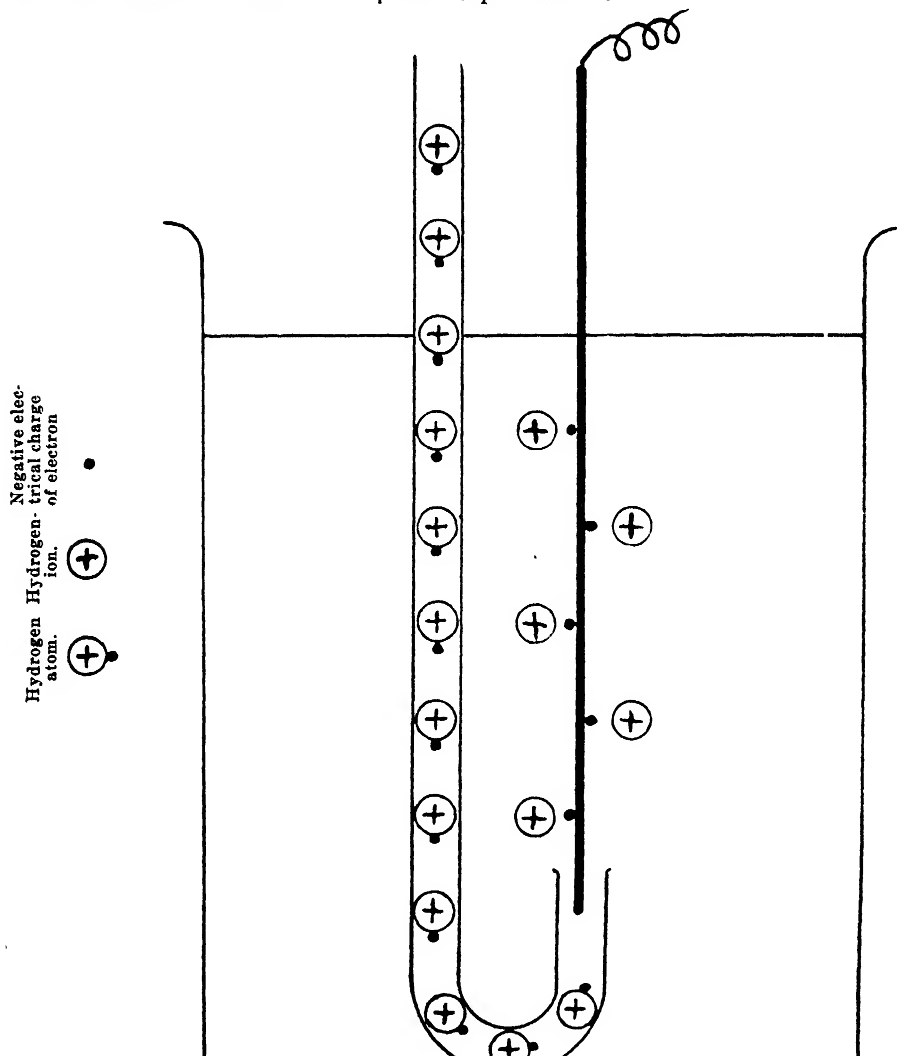
The number of hydrogen ions formed in the solution from the gas is always small, but is governed strictly by the number of such ions already present derived from other materials in the solution. Therefore, the potential developed between the platinum wire and the solution may be used to measure the number of ions already present.

The scale chosen by which to measure the hydrogen-ion concentration is known as the pH scale. It has been so chosen that a tenfold change of hydrogen-ion concentration is represented by one pH unit, one hundredfold change of hydrogen-ion concentration by two pH units, one thousandfold change of hydrogen-ion concentration by three pH units, and so on. For purposes of convenience, the pH values are made inversely proportional to the hydrogen-ion concentration, that is, as the hydrogen-ion concentration increases the pH value decreases. Therefore, an acid solution, which is one with a large concentration of hydrogen ions, has a low pH value, and an alkaline solution, which is one with a small concentration of hydrogen ions, has a high pH value.

Water itself always dissociates to some extent, that is, it breaks up into hydrogen ions and hydroxyl ions as follows:—

$$H_2O = H.OH \rightarrow H^+ + OH^-$$

It will be noted from this equation that hydrogen ions and hydroxyl ions are formed in equal quantities, and also that they carry opposite types of electricity, positive and negative. Thus the water remains electrically neutral. The hydrogen-ion concentration of water corresponds to pH value 7.



Hypothetical Picture of Hydrogen Electrode.

Acids are substances which dissociate in aqueous solution and give rise to hydrogen-ions. Consequently, when an acid is added to water the hydrogen-ion concentration increases and the pH value decreases.

Now it is a property of water and aqueous solutions that the product of the hydrogen-ion concentration and the hydroxyl-ion concentration is a constant quantity. Consequently, if one concentration is increased, *e.g.*, the hydrogen-ion concentration by the addition of an acid, the other concentration must decrease. When an alkali is dissolved in water it gives rise to hydroxyl ions. Therefore the hydrogen-ion concentration decreases and, of course, the pH value increases.

THE INFLUENCE OF HYDROGEN-ION CONCENTRATION ON MICRO-BIOLOGICAL GROWTH AND CHEMICAL REACTIONS.

The hydrogen-ion concentration of a medium, almost invariably expressed as the pH value, greatly affects a very large number of biological and chemical changes. Thus, the yeast-maker, who wishes to obtain a vigorous growth of yeast in his wort, adjusts the reaction of the wort to be slightly acid, for it has been found that the optimum pH value of the wort for yeast growth is about pH 4. The bacteriologist, wishing to obtain a vigorous growth of bacteria, adjusts the reaction of the media he uses to be slightly alkaline, about pH 7.2 to 7.4, for bacteria generally flourish best in this condition.

Referring to dairying matters, we may consider the counting of yeasts, moulds and bacteria in butter samples. The yeast and mould count is obtained by using a plating medium containing food materials particularly suited to the needs of the yeasts and moulds and adjusted to pH 4.7, an acidity which is very favourable for yeast and mould growth, but is not conducive to bacterial growth. For bacterial counts another medium is used for plating which is particularly suited to the needs of bacteria; the pH is adjusted to 7.2, which represents a condition very favourable for the growth of bacteria, but not for the growth of yeasts and moulds.

As an example of the effect of hydrogen-ion concentration on a chemical change, one may cite the case of the decomposition of esters in aqueous solution. Esters are organic compounds which are largely responsible for the characteristic odours and flavours of fruits and flowers. In aqueous solution esters slowly decompose into an acid and an alcohol, and this change is greatly accelerated by the presence of the hydrogen-ions derived from strong acids.

Referring back to dairying matters one may take the case of the oxidation of butterfat. This change was studied by Briggs (Jr. Dairy Science III., No. 1, p. 61) who found that the preliminary lag in the process was shortened from 15.75 to 11.75 hours in a given experiment by the presence of 0.1% of lactic acid. pH values were not determined.

RESULTS OBTAINED BY PREVIOUS WORKERS.

(1) Arup & Gilmour. Jr. Irish Free State. XXXII. No. 2, p. 257, and Gilmour, p. 273.

As a result of the work quoted in this paper, it was found that "On correlating the pH values and the flavour scores—there was a decided tendency for the flavour score to diminish as the acidity increased—*i.e.*, as the pH value decreased."

The value of a knowledge of the pH value in judging the suitability of butter for storage was also noted. "Altogether, out of the 72 boxes stored only 12 depreciated in flavour by more than 2 points; of these 10 had pH below 6.7, one had pH 6.7, and one had a pH above 6.7. Further, out of the 72 boxes only four fell below export quality, and all these had low pH values. Remembering that but one-third of the butters had pH values below 6.7, the number with low pH that depreciated appreciably in flavour was out of all proportion to the depreciation of those with high pH. In agreement with this is the well-known fact that starter butters do not store so well as those made from fresh cream. This is possibly merely a more exaggerated case than the present one of pH difference.

"The conclusion arrived at is that when butter is to be cold stored, only lots of high pH should be selected."

In this research work the Irish workers noted little change in the pH values of the samples during storage. The following figures are taken from their report:—

Temperature of Storage.	Number of Boxes Stored.	Average Change in pH.	Maximum Change in pH.
— 2° C.	24	—0·05	—0·20
— 6° C.	24	—0·01	0·15
—12° C.	24	—0·01	—0·15
Time of Storage, 6 months			

(II.) Loftus-Hills, Scharp & Bellair, Jr. Dairy Res. V., No. 2, p. 124.

These workers found that, "With the exception of the erratic result for the one butter in the pH range 5.0-5.5 there is a distinct association between pH and change of grade."

"The boxes of butter were stored at about 12deg. F. After three months they were removed, regraded, and again sampled, the samples being examined by same methods as before."

The following table shows the results which were obtained:—

——	Number of Butters Changing in Grade (points).				
pH values	1	0	—1	—2	—3 or more
5·0—5·5	1	...	...	...	...
5·5—6·0	...	2	2	3	1
6·0—6·5	...	11	11	3	1
6·5—7·0	1	4	7	1	...
7·0—7·5	1	5	8	1	...
7·5—8·0	...	2	...	...	...

As the samples were examined before and after storage it is interesting to note the change in pH values found by these workers.

"The decrease in pH on storage averaged 0.16, the values ranging from an increase of 0.03 to a decrease of 0.62. . . . . . . There was a distinct tendency for the pH of high pH butters to decrease more than that of the low pH butters. The change in acidity was not related to the change in grade."

THE EXPERIMENTAL PROCEDURE.

The information to be later presented in this paper was obtained from the analysis of 236 samples of butter cold-stored in Perth during the 1937-38 butter storage season. Before the storage commenced in Perth the material may have been subjected to temperatures ranging up to 60deg. or 70deg. F. for five or six days. In cold store the temperature would be maintained about 10deg. F. As the samples were taken from ordinary cold storage material, the time of storage varied. The minimum time any sample was stored was six weeks, the maximum fifteen weeks. The greatest proportion were stored between eight and eleven weeks.

THE MEASUREMENT OF THE pH VALUES OF THE BUTTER SERA.

The pH values of the samples were determined according to the methods described by the writer in Jr. Dept. Agric. W.A. Vol. XIII., Series 11, No. 3, pp. 349-354, Leaflet No. 485. The electrode vessel was not modified in any way, but in lieu of the Cambridge instrument a Tinsley potentiometer, type 3387B, with a Tinsley reflecting galvanometer, type S.L. 6 (coil resistance 74 ohms, sensitivity 126 mms/10^{-6} amp.) and universal shunt was employed.

With this method for determining the pH values, the limiting factor for the time required to perform a determination is the time employed in cleaning the platinum electrode which is used in the serum, and no matter what particular type of apparatus is employed, the cleansing of this electrode must always be carried out most carefully. The preparation of the samples for measurement may be carried out by a trained assistant whilst the chemist makes the actual potential measurements.

A constant temperature chamber was not employed, the temperature of each sample being taken immediately after the potential determination. A thermometer with a very small thin-walled bulb is required because of the small volume of serum used in each test.

The most unsatisfactory point in connection with the method of measurement is the drift in the potential reading. This drift, of course, is not peculiar to work connected with pH determinations of butter serum, being experienced with many substances, *e.g.* soils, when quinhydrone is used for one of the half-cells. It is probably caused by oxidation or reduction reactions affecting the quinone-hydroquinone balance in the quinhydrone. With a view to overcoming the difficulty, it is proposed to extend the research using the glass electrode in place of the quinhydrone.

THE CORRELATION BETWEEN THE INITIAL GRADE, THE FALL IN GRADE AND THE pH VALUES.

The following table has been drawn up to show the correlation which was found between the initial grade, the fall in grade, and the pH values:—

——	Grade initially.			
pH values	93	92	91	90
	%	%	%	%
>7·2	33·3	13·9	...	3·8
7·1—7·2	20·8	2·8	6·2	...
7·0—7·1	8·3	5·5	8·6	5·8
6·9—7·0	12·5	8·3	6·2	9·6
6·8—6·9	...	8·3	11·1	11·5
6·7—6·8	...	16·6	16·0	32·7
<6·7	25·0	44·4	51·9	36·5
Average drop in grade points ...	2·0	1·3	1·0	0·02

The results presented in the table above show that there is quite a marked correlation between the initial flavour score and the pH values, the butters with the higher flavour scores being generally less acid than those with lower flavour scores. This finding agrees with the results obtained by the Irish workers.

Two points should be noted in this connection:—

(1) Is the selection of these nearly neutral, or even slightly alkaline butters due to the training of the graders to prefer this type? or

(2) Have they been chosen as the best quality material because, in neutral materials, as contrasted with acid materials, any off-flavours would not be sufficiently noticeable to command attention?

Certainly it is known to chemists working with flavouring materials that a slight degree of acidity may make very evident a flavour which would pass unnoticed in a neutral medium. In the writer's opinion it is probably the second factor which is of greatest importance.

The possibility of undesirable odours and flavours being present but masked because of the neutral condition of the material deserves investigation.

THE CORRELATION BETWEEN THE KEEPING QUALITY AND pH VALUES.

The following table has been drawn up to show the correlation between the pH values and the fall in grade of the various samples.

Fall in Grade.	pH Values.											
	<6·2	6·2–6·3	6·3–6·4	6·4–6·5	6·5–6·6	6·6–6·7	6·7–6·8	6·8–6·9	6·9–7·0	7·0–7·1	7·1–7·2	>7·2
Points.												
3 ...	50·0	12·5	...	6·6	3·7	3·6	...	4·0	...	...	7·1	7·1
2½ ...	...	...	...	..	...	...	...	...	...	...	.	14·3
2 ...	50·0	12·5	20·0	10·0	14·8	10·7	2·6	...	26·3	15·4	42·9	35·7
1½ ...	...	12·5	...	...	11·1	3·6	5·1	4·0	...	...	...	21 4
1 ...	...	25·0	20·0	33·3	18·5	39·3	41 0	20·0	31·6	30·8	21·4	21·4
½ ...	...	37·5	40 0	26·6	33·3	25·0	2·6	44·0	10·5	38·5	14·3	...
0 ...	...	...	20 0	23·3	18·5	17·9	48·7	28·0	31·6	15·4	14·3	...
Average Fall ...	2 5	1·2	0 8	0·9	0 9	0·6	0·5	0·6	0 9	0·8	1·4	1·8

Note.—Owing to the very small number of samples which had a pH value of 6.2 or lower, no great importance should be attached to the figures in the first column of the table.

The figures in the table are grouped to show the percentage of the butter samples which have the pH value at the head of the column and which deteriorated by the number of grade points shown at the left side of the table.

The results tabulated above are shown graphically on the next page. The butter is classed according to the number of grade points by which it deteriorated.

Assuming that the weight of butter in a given class will be roughly proportional to the number of samples in it, the areas of the chart appropriately shaded will be roughly proportional to the weight of butter so classified.

From the chart it is obvious that the optimum acidity for keeping quality is about pH 6.7-6.9. Judged on the results obtained with this set of samples, one would expect about 50 per cent. of the butter having a pH value in this range (6.7-6.9) to show no deterioration in quality, and not more than 5 per cent. of it to show a fall of 2 or 3 grade points.

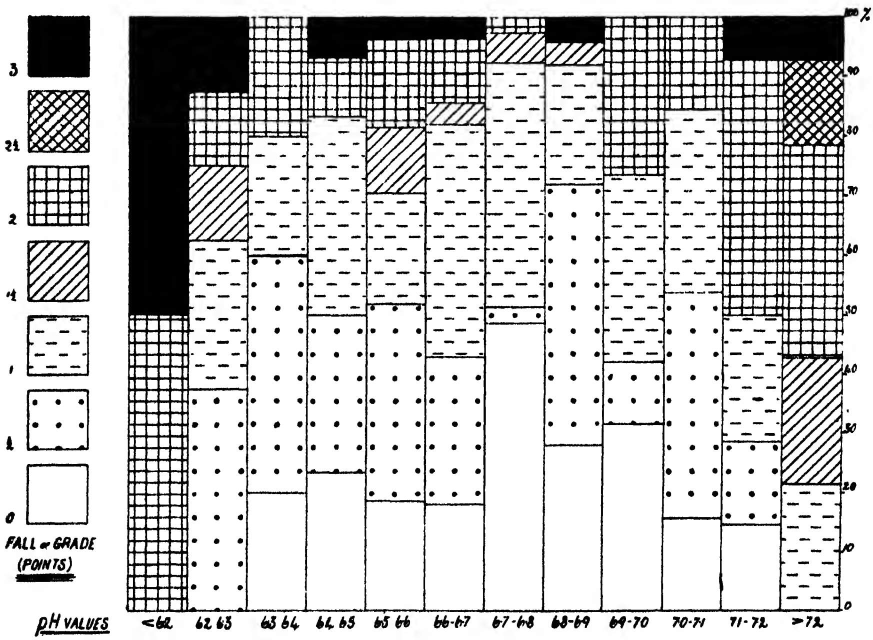
When the further possibility—that the slight acidity of a sample will probably show up any flavour defects—is taken into consideration, it is obvious that to produce high quality material which is going to maintain that quality, only the very best grade raw materials, coupled with carefully controlled manufacturing processes, are allowable.

The chart also shows that it is not desirable to store butter having a pH value greater than 7.1 or less than 6.3, for only a small percentage outside this range will maintain its initial grade.

In so far as there is on the average a greater depreciation in flavour score among the samples having pH values below 6.7 than among samples having pH values between 6.7 and 6.9, the results agree with those obtained by the previous workers for Irish and Eastern States butter.

Moreover there is the additional fact that the samples having pH values greater than 6.9, also tended to deteriorate to a greater extent than those having pH values between 6.7 and 6.9. One would suspect bacterial decomposition in this case because of the neutral to slightly alkaline nature of the material. But

GRAPH SHOWING CORRELATION BETWEEN pH VALUES AND KEEPING QUALITY.



bacterial growth would not be expected at the low temperature of storage, about 10deg. F. This is supported by figures obtained by the Irish workers, of which the following are representative:—

Organisms Counted.	Average Change.
	%
Yeasts	—51·3
Moulds	—83·3
Bacteria	—66·5

(Temperature of storage —12° c., time 6 months.)

It must be remembered, however, that in the case of the West Australian butter, a large proportion of the samples may have been kept at temperatures far above final storage temperature for some days before cold storage commenced. During this pre-storage period considerable bacterial growth may have taken place with consequent enzyme production, which latter would slowly attack the butter during the storage period.

In view of the information obtained, it is interesting to examine the pH values of the butter samples from various Western Australian factories. This information is shown in the following table:—

	Factories.							
pH values	901	903	910	911	912	913	914	915
>7·0	62·1	50·0	66·6	25·9	10·3	8·3	3·8	7·7
<6·3	3·4	.	...	3·4	3·4	8·3	7·7	1·9
6·7—6·9	6·9	50·0	11·1	22·2	58·6	25·0	23·1	35·0
Average pH	7·00	6·93 *	7·08 *	6·77	6·76	6·69 *	6·60	6·57

*Insufficient number of samples submitted to give the figures any great value.

The table shows that the factories numbered 901 and 911 are making a large percentage of their butter with a too high pH value for it to have good keeping quality. However, this may be a desirable condition in material for quick-sale purposes, as, generally, a high pH value is correlated with high initial grade. The same remarks probably apply also to the factories numbered 903 and 910, although the number of samples examined was too small to draw a really reliable conclusion in these cases.

FURTHER POINTS ARISING OUT OF THE WORK.

Examination of the tubes of centrifuged material before the contents are disturbed by drawing off the serum, gives an excellent indication of the amount of extraneous matter present in the butter. During the process of centrifuging, such material, having a higher specific gravity than the fat or serum, is thrown to the bottom of the centrifuge tubes, and, by examination of the tubes from beneath an idea of the relative cleanliness of the samples is obtained.

Quite a large number of the samples had an appreciable amount of sediment, the source of which is difficult to state with accuracy at present.

THE CORRELATION BETWEEN THE TITRATABLE ACIDITY OF CREAM AND THE pH VALUE OF THE BUTTER PREPARED FROM IT.

In order to utilise the information presented above, it is necessary to know the relation hip between the titratable acidity of cream and the pH value of the resultant butter. To obtain this information reference should be made to the work of Wiley (Dairy Res. Inst., N.Z. Pub. 104, 1937). By interpolation from the results presented in the paper, it is seen that to obtain a final pH value of 6.7-6.9 in the butter serum, a titratable acidity of 0.10-0.12 per cent. (lactic acid) should be produced in the cream.

SUMMARY AND CONCLUSIONS.

As a result of the work reported in this paper it is concluded that:—

(1) There is a marked correlation between the initial flavour score and the pH values, the butters with the higher flavour scores being generally less acid than those with lower flavour scores.

(2) There is a marked correlation between the keeping quality in cold store and pH values. The optimum acidity for keeping quality is about pH 6.7-6.9.

(3) The electrometric method for the determination of the pH values of butter sera referred to in the paper is convenient, rapid, and well adapted to the work.

(4) The method for the separation of the butter sera referred to in the paper enables one to make simultaneous examinations of the quantity of extraneous matter in the butter samples.

ACKNOWLEDGMENT.

The work reported in this paper was made possible by a donation from the Dairy Products Marketing Board for the purchase of the Tinsley Potentiometer and subsidiary apparatus.

AGRICULTURAL PROBLEMS.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

Albany	H. R. Powell (Fruit); B. Williams (Dairying).
Bridgetown	A. Flintoff (Fruit); A. M. Tindale (Dairying).
Bunbury	M. Cullity.
Geraldton	N. Davenport (Government Buildings).
Gosnells	R. C. Owen.
Harvey	R. L. Cailes (Fruit).
Katanning	A. S. Wild.
Kalamunda-Roleystone	W. H. Read, c/o. Department of Agriculture, Perth.
Kununoppin	W. M. Nunn.
Manjimup	C. M. Scott.
Metropolitan, Gingin, Chittering ...	S. E. Bennett, c/o. Department of Agriculture, Perth.
Mundaring	V. Cahill.
Narrogin	A. T. Gulvin.
Vasse	J. M. Nelson.

PASTURE RENOVATION.

H. G. ELLIOTT,
Agricultural Adviser, Dairy Branch.

In many countries it has been recognised for a long while that the harrowing of pastures and the mechanical renovation of certain types of pastures, more particularly Paspalum swards, are essential and a feature of efficient pasture management.

At the present time there are many makes of pasture harrows on the market, all of which are suitable for their particular purposes. It is generally recognised to-day that the autumn and winter harrowing of pastures is best carried out with a combination of the zig zag and chain types.

Autumn harrowing of pastures is a very valuable practice, which may be carried out to advantage during April and May. The principal benefit of this harrowing is to distribute animal droppings which, if not scattered, brings about a deterioration of the pasture in that rank patchy growth occurs; this is not liked and very seldom eaten by stock. If full advantage is to be taken of the fertilising ingredients in these droppings, they must be spread as uniformly as possible over the field by means of the harrows. Usually a cross-harrowing is essential in the early part of the season to obtain this uniform spread. It is not recommended to continue this harrowing late into the spring, as fouling of the grass will occur if rain does not follow soon after harrowing.

Renovation with some form of tyned or rotary renovator can be carried out successfully on subterranean clover pastures prior to germination. This renovation produces a surface mulch which, when the first rains occur, will absorb all the moisture, thereby assisting the young clover plants to withstand any drought periods which may occur prior to the general winter rains.

Renovation of Sod Type of Pastures.

It is quite frequently noticed in the sod type of grass pasture that an unfavourable condition for maximum pasture growth commences once the sward is well established, and many failures to obtain a satisfactory response to fertilisers on sod bound paspalum areas have been due to unsuitable conditions to produce results.

In old neglected paspalum pastures, very little if any clover, and practically no paspalum growth, are obtained. This condition is brought about by dead root accumulation in the upper layers of the soil, which acts as a thatch and interferes with the development of the young roots and the aeration of the soil. To overcome this, the first essential operation is to clean off any long grass growth and dry material from the field. This operation is necessary, otherwise renovating implements, more particularly the rotary type, and grass harrows will clog up, thereby not doing effective work.

The best time to renovate is in the autumn to early winter months. Two types of renovators can be used, namely, the rotary and tyned types.

The amount of renovation necessary to work an area satisfactorily depends on the age and condition of the pasture. In the case of badly sod bound paspalum, kikuyu, or couch grass pasture, two or even three workings 3 to 5 inches deep may be required. The second or last renovation should be across the previous one. Fertiliser should then be applied, and the complete area harrowed with pasture harrows to distribute animal droppings, smooth the surface, and create a soil mulch.

INFECTIOUS ARTHRITIS IN LAMBS.

A. McK. CLARK, L.V.Sc., Chief Veterinary Surgeon.

Arthritis in lambs is not uncommonly seen in this State and owing to its infectious nature appears to be slowly spreading. It is on this account that the attention of every sheep owner is drawn to the possibility of its appearance amongst his flocks, and the consequent need for added precautions during routine work of "marking."

When an outbreak of this disease occurs a considerable loss results economically from the inability to fatten those affected at the required time—if, in some cases, at all. Some develop into the "crippled" condition and do not recover.

Although arthritis affects lambs particularly, any mature sheep may become affected—sex playing no definite part. One can recognise the disease in the following observations of affected sheep:—

Symptoms.

The lamb firstly shows dullness and ceases to feed. The gait becomes stilty and there is stiffness and soreness when walking. This stiffness and soreness may be confined to one limb, but eventually two or more become affected. The lameness is due to joint affection and the consequent pain in those areas results in a disinclination on the part of the lamb to flex or extend the joint, the hock, stifle, fetlock or any articulations of the limb being implicated. The normal action of the limb is affected in such a manner that the lamb becomes immobile. When the animal is forcibly driven the lameness to some extent wears off. A recumbent attitude of the lambs is particularly noticeable in cold weather and in the mornings. On closer examination no abnormalities are noticed around the joint. There are no swellings and the disease can only be detected in the abnormal walk of the lamb. The majority of affected lambs recover after a few weeks, whilst a few remain cripples for the remainder of their existence. Of those affected it is estimated that 5 per cent. remain permanently crippled. However, owing to the inability of those affected to move about normally, loss of condition ensues, this being a retarding factor in their normal growth and their readiness for market.

On post mortem examination the articular surfaces of the joint show ulcerations. The bone when boiled and cleaned shows "pittings" on the surfaces referred to.

Cause.

The cause of infectious arthritis is a specific bacillus which has a selective affinity for the joints. This germ apparently infects the soil and gains access to the bodies of the lambs through open wounds. The disease makes its appearance usually after "marking," *i.e.*, the infection gains access through the open wounds resulting from de-tailing, castration and earmarking, and in particular any wound which may have contact with the soil.

Remedy.

There are no known means of curing the disease.

Prevention.

Something can be done in connection with prevention. Great care should be taken when "marking" to prevent the infection of wounds caused by de-tailing, castration and earmarking. All instruments should be cleansed by boiling in a solution of water and carbonate of soda for 10 to 15 minutes or allowed to soak in hot antiseptic solution. The operations comprised in "marking" should be done in yards which are not in constant use. A temporary rail should be erected in

well-grassed areas if possible, and a new site selected each year. When the operations are completed the lamb should not be carelessly dropped on to the ground but placed thereon so that it can walk away without the possibility of its wounds coming in contact with the ground or soil. Antiseptics may be used. Care should be taken that the operator and attendants have clean overalls, and that their hands be kept free from dirt as much as possible. It is of the utmost importance that all wounds be kept free from contamination.

NOTICE TO FRUIT GROWERS.

Regulations gazetted under the Plant Diseases Act, 1914-1938, on the 20th May, 1938, make it compulsory to use the following bait and instructions regarding infested fruit:—

COMPULSORY FRUIT FLY FOLIAGE BAIT.

Formulae:

(1) 1 oz. Sodium fluosilicate
 2½ lbs. sugar
 4 gallons of water

(2) *For household use.*
 Stock solution for keeping:
  1 dessertspoonful Sodium fluosilicate
  1 pint of water

 For use:
  3 tablespoonfuls stock solution
  3 tablespoonfuls sugar
  1 pint of water

(3) *Proprietary Mixture*:
 A ready to use Sodium fluosilicate bait is obtainable under the name of "109."

The addition of any fruit juices in season will increase the attractiveness of the baits.

All mixtures should be kept agitated while in use.

Quantities.

A gallon of mixture is sufficient to treat 40 trees or 100 grape vines. For backyard trees about half a cup of bait is sufficient.

Method of Application.

The mixture should be applied to the foliage on two or more sides of the tree with a spray pump or syringe, or splashed on with a whitewash brush or perforated tin, once every six days. Apply six weeks before fruit is ripe and two weeks after fruit has been stripped.

All infested fruit must be picked from the trees and the ground daily and destroyed by boiling or steeping in a vessel containing water and kerosene for three days.

Warning.

The quantities stated in the formula given above should be rigidly adhered to, for at the strength quoted Sodium Fluosilicate, while quite effective in destroying fruit flies, is harmless to human beings.

ALL-AUSTRALIA EXPORT LAMB COMPETITIONS, 1937-1938.

The Australian Meat Board has made available the following report of last year's (1937-38) All-Australia Export Lamb competition judged by Mr. J. I. Hamilton.

Although this competition has been concluded for some time and the results have been made available to the Press, this report gives the details of the different points scored under each heading, and the judge's comments on the competition.

JUDGE'S FINAL REPORT.

CLASS I.

Lambs sired by Southdown rams.

CLASS II.

Lambs sired by other breeds of British rams.

The number of entries judged was 131 in Class I. and nine in Class II., a total of 700 carcasses. The entries were made up as follows:—

	Class I.	Class II.	Total.
South Australia	59	..	59
Tasmania	34	1	35
Victoria	17	4	21
New South Wales	10	3	13
Western Australia	9	1	10
Queensland	2	..	2
	131	9	140

In Class I. the standard of quality was a high one, 72 of the 131 pens scoring 75 per cent. or more of the possible points. Of the remainder, 40 pens scored between 70 and 74 per cent., and there were 19 below 70 per cent., including four below 60 per cent. Two of the latter were from Victoria and two from New South Wales and none of these were considered up to Class I. standard.

The Tasmanian entries included the Grand Champion and should be mentioned first. The winning entry (Messrs. N. S. and I. A. Badcock) were the only two pens in one entry to score each over 90 points, and the aggregate of 193 was a phenomenally high one. The average number of points scored by the Tasmanian entries was 78.8.

Western Australia.—High as was the Tasmanian average of points scored, it was exceeded by the Western Australian entries with 80.5. The highest number of points scored by a Western Australian entry was 94 in the case of Mr. B. D. Bothe's pen, No. 2, and five pens scored 80 or more.

Victoria.—Although a Victorian entry was successful in the Southdown Championship (and in Class II. also) the number of entries received from the State was disappointingly small and they were not up to the standard expected.

The winners (Mr. E. C. Henry's pens, Nos. 9 and 12) were two outstandingly well balanced pens, but these were a long way ahead of anything else from Victoria. The highest number of points scored was 92 (Mr. E. C. Henry's pen No. 9) and the average for the State 75.6.

South Australia.—As regards the number of entries combined with a high average, South Australia's was the most creditable performance. Entries totalled 59 (in Class I.) and the highest number of points scored was 90, with Mr. T. Ridgway's Pen No. 17 (September). The average number of points scored by

the South Australian entries was 74.9, and it was very noticeable that they were at their best in the early competitions and fell away later.

Queensland.—In point of fact Queensland has the highest average of points scored, viz. 90, but entries from that State were confined to Mr. Prentice's (Nos. 1 and 2). Mr. Prentice enjoys the distinction of having gained the highest number of points for a pen—96—with the single exception of the Grand Champion (first pen) and of demonstrating that, under certain circumstances, export lambs can be produced in Queensland as well as anywhere else in Australia or, for that matter, other countries which export lambs to the United Kingdom.

In competitions, where a high standard was set and only eight of the 131 entries (in Class I.) scored 90 points or more, it is very gratifying to find that each State contributed a pen to this distinguished list. The following is the list:—

N. S. & I. A. Badcock (No. 1), Tasmania	98
F. Prentice (No. 1), Queensland	96
N. S. & I. A. Badcock (No. 2), Tasmania	95
B. D. Bothe (No. 2), Western Australia	94
*A. J. Archie & Son (No. 36), Tasmania	94
E. C. Henry (No. 9), Victoria	92
T. Ridgway (No. 17), South Australia	90
*Memsie Pastoral Co. (No. 2), N.S.W.	90

*Only one pen entered.

Class II.—Entries in this Class were disappointing as regards numbers, totalling only nine in all, and, in fact, only two competitors submitted the required number of pens to be eligible for the prize.

The prize went to Messrs. E. and B. Hawkins, Victoria, but the Longerenong Agricultural College, Victoria, entered the pen which scored the highest number of points—82. The five leading pens (Messrs. E. and B. Hawkins (2), Agricultural High School, New South Wales, and Longerenong College) were good commercial types, but contrasted very unfavourably with the Southdown Class.

Breeding Ewes.—No definite conclusions could be drawn from the results of the competitions with regard to the suitability of breeding ewes. The contrast between the entries in Class I, and Class II. however, was so marked that it seems possible that at least in many districts the Southdown ram can be used to advantage to cross with any of the ewes available and produce a more or less improved type of export lamb. Obviously where it is possible to select ewes for type the best results should follow.

General.—The displays of the competition lambs created a great amount of interest and no doubt revealed to retailers that each State is capable of producing the ideal type of carcase. There still lingers a prejudice in the minds of a section of the trade, but displays of lambs comparable to any from other countries can be relied on to further remove this prejudice.

Visitors from the provinces were particularly impressed and it may confidently be expected that early shipments of Australian Down type lambs will be more eagerly sought for. In several instances retailers who made purchases of the competition lambs remarked on the wealth of meat to bone and on the pale and attractive appearance of the flesh which gave entire satisfaction to their customers.

It is recognised, of course, that lambs of Class II. represent the bulk of Australia's exports and that it is of the utmost importance that these should not be in any way overlooked. It is the Down type, however, which is demanded and one object which the competitions achieved was to demonstrate that this type is being developed in Australia with marked success.

The trade can safely be relied on to note the improvement in the Class II. type of lambs, but the development of the Down type is one which can profitably be advertised.

Judging was carried out on the following scale of points:—

		Points.
A.	Correct amount of fat and proportion of lean flesh to fat ...	50
B.	Back and filling over loins	25
C.	Depth and twist of meat on all four quarters	25
	Total	100

The following is a complete list of entries and points awarded:—

CLASS 1

Competitor.	Entry No	State.	Points. A.	B.	C	Total	Total, 2 pens	Breed of Ewe
N S & I A Badcock	1	Tas.	48	25	25	98	193	English Leicester cross
Do do.	2	,,	45	25	25	95		
E C Henry	9	Vic.	45	23	24	92	181	Crossbred
Do	12	,,	44	20	25	89		
F. Prentice	1	Qld.	48	24	·24	96	180	Lincoln-Merino cross
Do	2	,,	44	20	20	84		
B D Bothe	2	W.A.	48	23	23	94	179	Border Leicester-Merino cross
Do	3	,,	45	20	20	85		
*A. J Archie & Son	36	Tas	44	25	25	94		Crossbred
T. Ridgway	17	S.A.	46	22	22	90	174	Border Leicester-Merino cross
Do	5	,,	44	18	22	84		
† Do	28	,,	38	18	18	74		do do do
† Do	27	,,	36	17	16	69		do do do
*Memsie Pastoral Co	2	N.S.W.	50	20	20	90		Romney Marsh-Merino cross
T. R. Seeker	2	S.A	46	22	20	88	173	Corriedale-Merino cross
Do	1	,,	45	20	20	85		
W. & C Von Bibra	12	Tas	42	22	22	86	166	Crossbred
Do. do	8	,,	42	20	18	80		
Cox Bros	5	W.A.	45	20	20	85	165	Border Leicester-Merino cross
Do	4	,,	38	22	20	80		
Reg C. Grubb	59	Tas.	45	20	20	85	164	Romney-Corriedale
Do	58	,,	38	20	20	78		
† Do	46	,,	38	18	18	74		do
† Do.	47	,,	38	20	16	74		do
*Cowling & Hughes	4	S A.	44	20	20	84		Merino
H. L. Harvey	41	Tas.	45	20	18	83	163	Crossbred
Do	42	,,	42	20	18	80		
† Do	40	,,	40	20	18	78		do
Roseworthy College	6	S.A.	42	18	22	82	162	Border Leicester-Merino cross
Do. do	1	,,	40	20	20	80		
† Do do.	2	,,	38	18	20	76		do do do.
Lett's Stud	19	S.A.	42	20	20	82	162	Corriedale-Merino cross
Do.	18	,,	40	20	20	80		
† Do	29	,,	38	18	16	72		do do
† Do.	42	,,	38	16	18	72		do do.
† Do.	23	,,	36	17	18	71		do do
W. Fraser & Son	21	,,	42	20	20	82	162	Merino
Do.	16	,,	40	20	20	80		
Estate W W. Mitchell	11	W.A.	42	20	20	82	161	Border Leicester-Merino cross
Do. do.	10	,,	43	18	18	79		
R. K. Heazlewood	9	Tas.	40	22	20	82	160	English Leicester cross
Do.	10	,,	40	20	18	78		
† Do.	55	,,	36	18	16	70		English Leicester-Merino cross
† Do.	56	,,	36	18	16	70		do do. do.
*W. A. O'Neill	6	N.S.W.	40	20	22	82		S.D. Border Leicester-Merino (2 lambs overweight)
*T. J. B. Scott	57	Tas.	42	20	20	82		Crossbred
R. B. Mills & Sons	18	Vic.	40	20	20	80	158	do.
Do. do.	8	,,	42	18	18	78		
G. & E. A. Brooks, Ltd	13	S.A.	40	20	20	80	158	Romney Marsh-Merino Come-back
Do. do	11	,,	40	18	20	78		
† Do. do	15	,,	40	18	20	78		do do do.
† Do. do.	10	,,	40	17	19	76		do. do. do
† Do. do.	12	,,	38	18	20	76		do do. do.
† Do. do.	14	,,	40	18	18	76		do do. do.
† Do. do.	3	,,	38	17	20	75		do do. do.
† Do. do.	9	,,	39	16	20	75		do do. do.
† Do. do.	8	,,	38	16	20	74		do do do
† Do. do.	4	,,	38	16	19	73		do do do.
† Do. do.	7	,,	38	16	18	72		do. do. do.
† Do. do.	26	,,	36	17	16	69		do. do do.
† Do. do.	25	,,	37	15	15	67		do. do do.
† Do. do	24	,,	35	15	15	65		do. do. do.

*Only one pen entered. †Additional pens.

CLASS I—*continued.*

Competitor.	Entry No.	State.	Points. A.	B.	C.	Total.	Total, 2 pens.	Breed of Ewe.
Fred Carr	7	N S.W.	40	20	20	80	158	Crossbred
Do.	8	,,	38	20	20	78		
R. C. Thompson	6	Tas.	40	20	20	80	158	Corriedale
Do.	7	,,	40	18	20	78		
† Do.	15	,,	34	16	16	66		
E. H. Thorpe	3	S A.	46	22	20	88	157	Merino
Do.	38	,,	35	16	18	69		
H. H. Shillabeer	49	,,	42	20	18	80	156	English Leicester-Merino (1 lamb overweight)
Do.	50	,,	40	18	18	76		English Leicester-Merino
† Do.	32	,,	40	18	18	76	.	English Leicester-Merino cross
† Do.	33	,,	40	18	18	76		do do do
J. P Hiscutt	4	Tas.	40	20	20	80	152	English Leicester cross
Do.	26	,,	38	18	16	72		
H. S. Henley	1	N S W.	40	18	18	76	152	Romney Marsh-Merino
Do	4	,,	40	18	18	76		
*F. T. Edwards	11	Tas.	40	20	20	80	....	Crossbred
*Lindsay Hughes & Son	37	,,	40	20	20	80		do.
H R. Heaziewood	3	,,	42	20	20	82	150	Romney cross-Romney cross Ewes
Do	54	,,	34	18	16	68		
Wm. Cook	62	,,	40	18	18	76	150	Crossbred
Do	61	,,	38	18	18	74		
† Do	50	,,	32	16	16	64	....	do.
R E Golder	34	S A	39	17	16	72	149	Border Leicester-Merino
Do.	35	,,	40	19	18	77		
† Do.	51		36	14	14	64	....	do. do.
*H V Rockliffe	27	Tas.	38	20	18	76	..	Corriedale
*H. D. Moodie	17	Vic	38	20	18	76	.	Border Leicester-Lincoln-Merino cross
C. E. Napier	5	Tas.	40	18	18	76		Crossbred
Sir J Lavington Bonython	40	S A	38	18	18	74	148	Border Leicester-Merino crossbred
Do do	41	,,	38	18	18	74		
Do do	22	,,	40	17	17	74		do do. do.
J. McGinty	52	Tas	40	20	16	76	146	Crossbred-Dorset Horn
Do.	39	,,	38	16	16	70		
W. G Burgess	1	W A.	40	18	18	76	146	Border Leicester-Merino cross
Do	19	,,	38	16	16	70		
F. N. Simpson	45	S A.	36	20	18	74	146	Leicester-Merino or Romney Marsh-Merino
Do	46	,,	38	16	18	72		
† Do	47	,,	38	16	18	72	..	do. do do.
† Do	48	,,	38	16	18	72	.	do do do.
† Do	52	,,	34	14	14	62	....	Romney Leicester-Merino
*G C Topham	8	W A.	38	18	18	74		Border Leicester-Merino cross
*J. B. Stephenson	39	S A.	38	18	18	74		English Leicester-Merino
*P. L Puckridge	30	,,	40	18	16	74	.	do do
*W. M McFarlane	31	,,	40	18	16	74	...	Romney Marsh-Merino
D. W. Taylor	43	,,	38	16	18	72	142	Border Leicester-Merino cross
Do.	44	,,	36	16	18	70		
† Do.	36	,,	38	16	16	70	....	English Leicester-Merino
† Do	37	,,	36	16	16	68	. .	do. do
Estate late D. MacKinnon	27	Vic.	38	16	18	72	142	Romney Marsh-Comeback cross
Do. do	28	,,	38	16	16	70		
*H. W. Tuck	3	,,	38	18	16	72	..	Romney-Merino cross
*D. S. Henderson	10	,,	38	18	16	72		1st cross Romney-Merino
*L. R Cooper	20	S A.	38	16	18	72		English Leicester-Merino cross
*T. Ridgway	54	,,	38	18	16	72		Border Leicester-Merino (1 lamb overweight)
A. W Giles	24	Vic.	36	18	18	72	140	Crossbred
Do	23	,,	34	18	16	68		
*F. L. Beveridge	60	Tas.	35	18	18	71	.	Polworth cross
A. G. Jenkins	55	S.A.	36	18	16	70	138	Merino
Do	53	,,	36	16	16	68		
W. E Sargood	2	Vic	40	18	17	75	135	Romney and Border Leicester-Merino cross
Do.	1	,,	40	10	10	60		
Graeme Leishman	19	,,	42	20	20	82	134	Lincoln-Merino cross
Do.	25	,,	29	11	12	52	...	do. do
*B. J. Stocks	5	N.S.W.	36	18	16	70	.	Border Leicester-Merino (3 lambs overweight)
Lauchlan Leishman	20	Vic.	40	18	18	76	128	Lincoln-Merino cross
Do. do.	26	,,	30	10	12	52		
*P. J. B. Osborne	9	N.S.W.	32	14	14	60	..	Romney Cross Ewe
*R. O. Williams	11	,,	30	14	12	56	..	Crossbred
*Agricultural High School	12	,,	32	12	10	54	...	Romney Marsh-Merino cross

CLASS II.

Competitor.	Entry No.	State.	Points. A.	B.	C.	Total.	Total, 2 pens.	Breed of Ewe.
E. & B. Hawkins	4	Vic.	44	18	18	80	150	Lincoln-Merino
Do.	5	,,	40	16	14	70		
Agricultural High School	15	N.S.W.	40	18	18	76	144	Romney Marsh-Merino cross
Do. do.	14	,,	38	15	15	68		
*Longerenong Agricultural College	11	Vic.	44	20	18	82	....	1st Lincoln-Merino cross
*W. G. Burgess	9	W.A.	36	16	16	68	..	Border Leicester-Merino cross
*H. R. Redditch	13	Vic.	32	18	14	64	..	Lincoln cross
*N. McKay Burbury	18	Tas.	32	14	14	60	..	Corriedale cross
*R. O. Williams	10	N.S.W.	30	14	14	58	...	Comeback Corriedale-Merino

*Only one pen entered. †Additional pens.

SOIL EROSION.

THE CONSTRUCTION OF CONTOUR BANKS.

By L. J. H. TEAKLE (Plant Nutrition Officer) and N. DAVENPORT (Agricultural Adviser—Wheat Branch).

The incidence of soil erosion has received very considerable attention all over the world during the last five years largely as a result of the surveys conducted by the Soil Conservation Service organised in the United States of America. The spectacular dust storms experienced in that country gave point to the warnings which agriculturists have repeated for a century and a half, and governmental agencies were led to finance technical investigations which showed that a serious position had developed. As a result of over-stocking, over-cultivation, cultivation in drought-liable areas and indiscriminate forest burning and cutting, very considerable areas of country were seriously damaged. reservoirs were silting up, and a national calamity was heralded by the abandonment of many thousands of farms largely as a result of soil erosion. Authoritative statements from America show that about 100,000,000 acres of erstwhile arable land have been ruined as far as further tillage is concerned. Furthermore, it is estimated that 75 per cent. of the arable land of the United States of America is in need of treatment to maintain its fertility level which is rapidly being reduced by soil erosion. In the case of water erosion on sloping country, the method of treatment is the construction of contour banks or terraces to control water movement.

Although such careful surveys have not been conducted in Australia there is ample evidence that soil erosion has taken heavy toll of farming land throughout the continent. While it is conceded that the damage is proportionally very much less serious than in the United States of America, "a competent observer from overseas has expressed the opinion that over one-half of Australia's wheat lands needs some form of erosion control, particularly by contour banks and strip cropping."[1] The interest of farmers in Western Australia in methods of preventing and remedying soil erosion damage has been much in evidence recently and there has been a demand for the details of those simple remedial and control practices which any farmer can adopt. Much of the information has already been published elsewhere but is not readily available for the farmers of this State so that repetition in this Journal is necessary.

Where Soil Erosion Occurs.

Soil erosion occurs largely in the hilly farming districts, particularly in the jam and york gum belt where the rainfall ranges from 15 to 20 inches per annum and where cultivation and cropping is a major phase of the agriculture. It almost invariably occurs where the slope of the cleared land is steeper than 2 degrees (3½ per cent.) and is evidenced by gullies and washes. These gullies and washes are not the primary condition but in themselves are the result of water running off the slopes and accumulating in the depressions, along sheep pads, tracks, etc. Following cultivation and heavy stocking, accentuated by the depredations of the rabbit, the ground loses its sponge-like qualities and water is not absorbed readily. Consequently, a considerable proportion of the rain runs off. Obviously, this is not only a loss of valuable moisture needed in the subsoil for crop growth, but damage to the soil results from the carrying away of the rich surface layers and the cutting of gullies through paddocks.

[1] "Conserve your Soil: A simple guide to Erosion Control," published by the Bank of New South Wales.

The Control of Soil Erosion.

The control of soil erosion, whether by water or wind, primarily involves proper farm management. The actual details of the most satisfactory management will vary from district to district and will depend on the nature of the soil, slope, etc. Whatever the conditions, crop rotation must be adopted to maintain, as far as possible, the absorbent qualities of the soil. This will involve the use of a pasture period, and avoidance of excessive cultivation and cropping and overstocking. Wind breaks will be an additional factor in the control of wind erosion.

For the more direct control of water erosion on slopes the construction of contour banks is the first essential.

Contour Banks.

For countless generations terraces and hillside ditches have been used to control the rush of water on slopes. The modern development, however, dates from 1885 when Mr. Mangum, of Wake Co., North Carolina, devised a broad base terrace, or contour bank which would effectively prevent accumulated water from running down slopes, would promote water absorption, and would allow free use of all farm implements. The banks are so constructed that a paddock may be worked in any way convenient to the farmer (just as if they were not present). It is generally advisable, however, to plough and/or cultivate slopes in narrow lands, following as near as possible the contour banks, and not round and round the paddock to finish in the centre.

The first essentials in terracing a paddock are the location of the outlet, determining the slope, the spacing of the contour banks, and pegging the lines the banks are to follow. This done, contour banks may be constructed by means of a plough, drawn either by horses or a tractor, by a special power grader or other suitable implement. In our experience we have found that the most suitable farm implement is a 4 or 5 furrow disc plough with large discs which will move a large body of soil each round. A mould board plough will do the job but is inconvenient on account of lack of lever control of depth of ploughing on the front carriage. The amount of work required in the construction of the banks is generally equivalent to plowing the whole paddock.

The contour bank is a structure about 20 feet across. It consists of (1) an upper ditch, which is broad and shallow, (2) a central, broad crown the top of which is 15 to 20 inches above the level of the bottom of the upper ditch, and (3) a lower, broad ditch. Figure 6D diagrammatically represents a contour bank. The resemblance to an ordinary formed dirt road will be apparent.

Generally, the contour bank is not constructed dead level but is given a slight fall (1 in 100 or 1 in 200) to allow the removal of excess water in times of heavy rains.

These banks are permanent. All that is required in their maintenance is the ploughing or cultivating of the earth to the centre of the crown whenever it has been reduced in height so much that an overflow in the event of a rain storm is likely.

*Points to be Considered.**

In order to be sure of a permanent and satisfactory job several points must be considered in the construction of contour banks.

1. Consult your agricultural adviser to get all of the information possible before starting.

* Adapted from "Crops or Canyons," published by the Caterpillar Tractor Co., Peoria, Ill., U.S.A.

2. Examine each field carefully and decide where the outlets to take excess water are to be located.

3. Determine the slope of the land and decide upon the distance apart of the banks and the fall to be given in each part of the banks.

4. Lay out the lines for the banks accurately, using a "level" giving the correct fall. Even out sharp turns.

5. Commence formation on the top bank and complete them as you go.

6. Fill in low places where water may accumulate and damage the bank.

7. Once started, finish every terrace, finish every outlet and complete the job.

The Home-made "Level."

A suitable instrument for pegging the contour banks is a home-made "level" which any handy man can make in a couple of hours. On account of weight, Oregon pine timber is recommended. Three pieces 4in. x 1¼in. by 8 feet long and one piece 6in. x 1¼in. by 12 feet 6 inches long will be required and are built into a frame as shown in figure 1. To make the structure rigid, it is recommended that a quarter inch scarf be cut in each piece of timber at the joints and that the frame be held together by means of quarter inch bolts. If three bolts are used at each joint, a dozen quarter inch by 2½ inch bolts with washers will be required. It is essential that the spread of the legs at the base be exactly 200 inches (16 feet 8 inches), and that the centre cross-piece be exactly parallel to a line joining the lower ends of the legs.

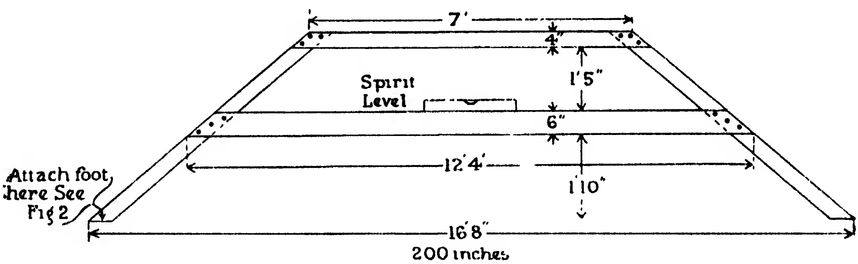


Figure 1

Details of the construction of the home-made "level." In the interests of lightness, Oregon pine is recommended but any other type of timber may be used. The overall length at the base must be exactly 200 inches and the centre cross-bar exactly parallel with the base line. The other dimensions may be varied if necessary.

An ordinary carpenter's spirit level is attached to the centre cross piece to determine when the lower ends of the two legs are exactly level.

To test the "level," set it up on a floor or smooth piece of ground so that the bubble of the spirit level is in the centre and mark the position of the lower ends of the legs. Then reverse the "level," end for end, placing the legs on the same spots. If the apparatus is in adjustment the bubble will still be in the centre. Should this be not so, the longer leg is shortened until the reading is correct.

For convenience in adjustment of the "level" for laying out contour banks of any desired slope an adjustable foot may be attached to one leg as shown in fig. 2. By using a double row of quarter inch bolt holes one inch apart, it is possible to adjust the foot in half inch intervals—that is, by intervals of one quarter per cent. slope. For the attachment of the parts of the adjustable foot, three bolts ¼in. x 1½in. and two bolts ¼in. x 3in. will be required.

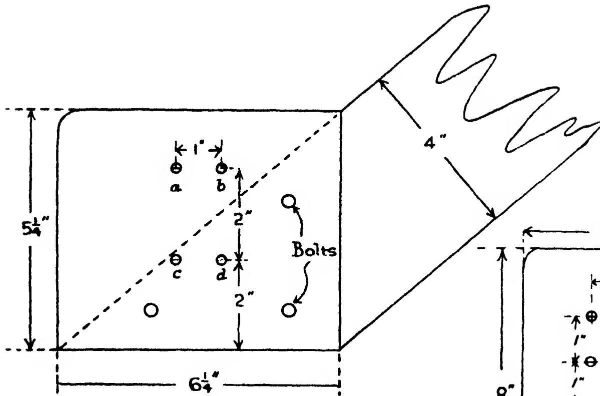


Fig 2A

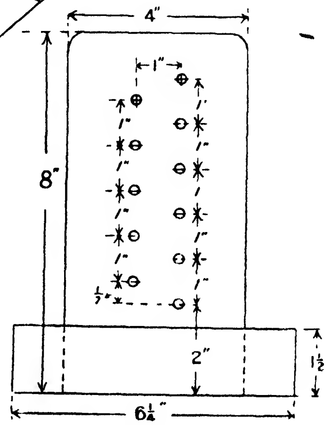


Fig 2B

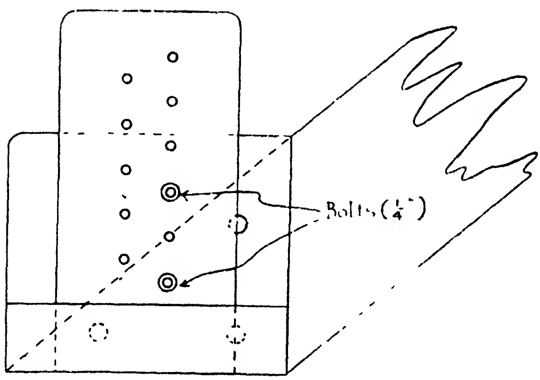


Fig 2C

FIGURE 2.

Details of the construction of the adjustable foot.

2A. The carrier for the adjustable foot. Half lap and bolt on to the end of one leg of the "level." Bore 4 quarter-inch holes, a, b, c, d, to take the bolts of the adjustable foot.

2B. The adjustable foot. The quarter-inch holes are 1 inch apart and staggered so that the adjustments may be made in half-inch intervals (*i.e.*, one quarter per cent. slope).

2C. The adjustable foot attached to the "level" by means of two quarter-inch bolts.

Decide Upon Outlets for Excess Water.

It is most important that outlets be provided for all contour banks so that excess water may be disposed of with greatest convenience and least damage. The best outlets are natural water courses or patches of absorbent scrub or pasture land, but if these are not available, broad, shallow drains may be constructed along fences or other convenient places, choosing a site with the minimum slope. These drains should be grassed, if possible, to bind the soil. Couch grass should be suitable in many districts. Rocks, brush, wire, etc., may also be used to protect the bottom of the drain from damage by the running water.

Laying out a Field for Contour Banks.

First of all, carefully examine the field for slope. This may be done by means of the "level" by placing the apparatus up and down the slope and measuring the height which the lower leg must be raised to bring the bubble into the centre. As the "level" is 200 inches long, if this eight is 16 inches, the slope must be 8 per cent. or 1 in 12½. From the slope, the spacing of the banks may be decided using the information in table 1 as a guide. If the land is very subject to erosion, these intervals must be adhered to rigidly, or even decreased, but if the soil is very absorbent, the spacing may be increased. It is unwise to increase the intervals too much as the enlarged catchment area above each contour bank means a greater concentration of water with consequent danger of sheet erosion between the banks.

TABLE 1.

*The Spacing of Contour Banks according to Slope.**

Fall of land per 100 feet horizontal.	Vertical drop between contour banks.		Distance between centres of banks along the slope.
feet.	feet.	inches.	feet.
3	3	0	100
4	3	6	87½
5	4	3	85
6	5	0	83
7	5	9	82
8	6	3	78
10	6	6	65
12	7	0	58

* E. S. Clayton: Control of Soil Erosion, N.S.W. Dept. of Agriculture Bulletin.

Second, decide upon the fall to be given the contour bank. If the bank is short, say not more than 10 chains long, a uniform slope of one per cent. should meet most requirements and the adjustable foot would be lengthened by two inches. If the bank is longer, a smaller slope should be given the next 10 chains—say one-half per cent. or one inch in 200. The portions of the bank more than 20 chains from the outlet may be given a one-quarter per cent. slope or one-half inch in 200. Less than one-quarter per cent. slope is not recommended for ordinary use on account of the difficulties involved in attaining greater accuracy with the "home-made" level.

Figure 3 illustrates the variable slope contour bank.

Third, commence on the topmost bank at the outlet and peg the line of the contour bank as determined by use of the level. Guesswork is positively dangerous

and will lead to waste of the effort put into the work as inaccurately located banks are more damaging than no banks at all. With the "level" the work may be done quickly and accurately and will lay the foundation for a permanent improvement.

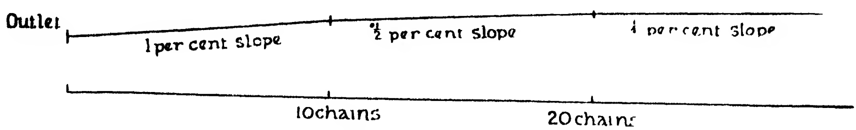


Figure 3

The variable slope contour bank. By this means the lower end of the bank can carry off an accumulation of excess water faster than if a constant slope of, say, half per cent. is used.

Figure 4 illustrates the method of pegging the position of a contour bank. It must be remembered that the lengthened foot must always be down the slope: in working up the slope it must be in the rear; in working down the slope of the contour bank it must be in front.

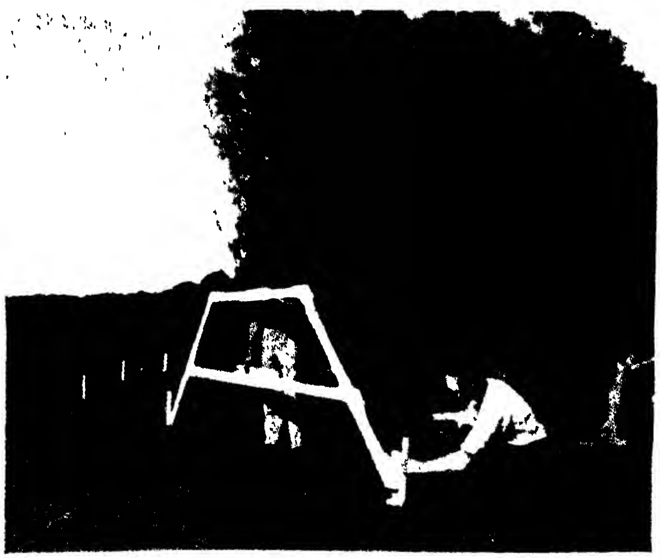


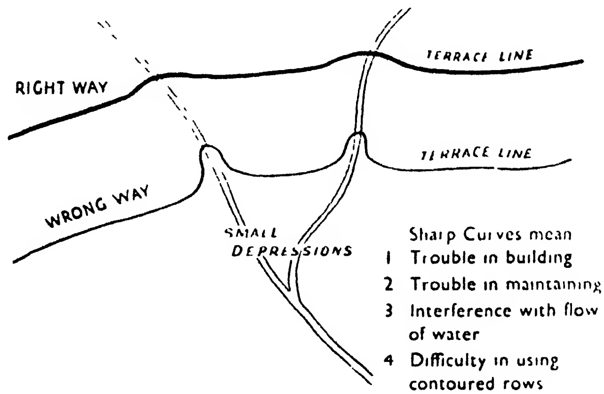
FIGURE 4.

Pegging out the position for a contour bank. A start is conveniently made from the outlet of the topmost bank. In this case the outlet is a creek with a good cover of vegetation along its banks. (Conserve your Soil: Bank of N.S.W. circular.)

Fourth, after a line is pegged it will be noticed that the stakes are somewhat irregular, due to the unevenness of the surface, and that there are sharp angles in the line where gullies or mounds occur. The small irregularities are evened out by adjusting the stakes to give smooth curves: in crossing gullies the lines are carried almost straight across and the depression filled in to the required height by means of a scoop or similar machine; mounds should be reduced likewise to allow unimpeded flow of water along the contour banks when necessary. Figure 5 illustrates the right way to carry contour banks across small depressions.

Constructing the Contour Banks.

A great variety of equipment may be used for constructing contour banks. Undoubtedly, suitably designed power graders are most economical if sufficient work to warrant the capital cost has to be done, but for the individual farmer the disc plough does a very satisfactory job. The most suitable plough has four or five



The Right and the Wrong Way to run terrace lines across small depressions

FIGURE 5.

Avoid sharp angles in constructing contour banks across depressions. (Conserve your Soil: Bank of N.S.W. circular.)

large discs and will give sufficient width in three rounds. Two rounds will give adequate width with a ten-disc cultivating plough, but this implement is not as convenient as the 4 or 5-furrow disc plough. Horse or tractor power is equally satisfactory. The crawler type of tractor is more suitable than the wheeled type, especially if the ground is wet.

Assuming a 4 or 5 disc plough is to be used, the procedure is as follows:—

1. Set the plough to cut a depth of at least six inches, if possible.
2. Strike out along the line of stakes laying the front furrow slice on the line. On the return trip of the first round throw the first furrow slice this time on top of the first furrow slice of the previous trip. This gives a crown the height of two furrow slices.
3. Then plough two more rounds as in ordinary ploughing to give a ploughed strip about 20 feet wide.
4. Again plough a round in the centre (round 4) laying the first furrow slices one on top of the other as in the first round. This gives a crown the height of four furrow slices.
5. Plough one more round as in ordinary ploughing.
6. Using the level, determine the height of the crown above the top drain. If the height is at least 15 inches the crown is sufficiently high and only needs broadening by ploughing two more rounds (rounds 6 and 7) keeping about 18 inches from the centre in striking out the 6th round.

If the crown is less than 15 inches high it will be necessary to plough additional series of rounds into the centre until it is built up to the required height.

Diagramatic representation of the process of constructing contour banks by means of a plough is given in Figure 6. Figure 7 shows a plough in action.

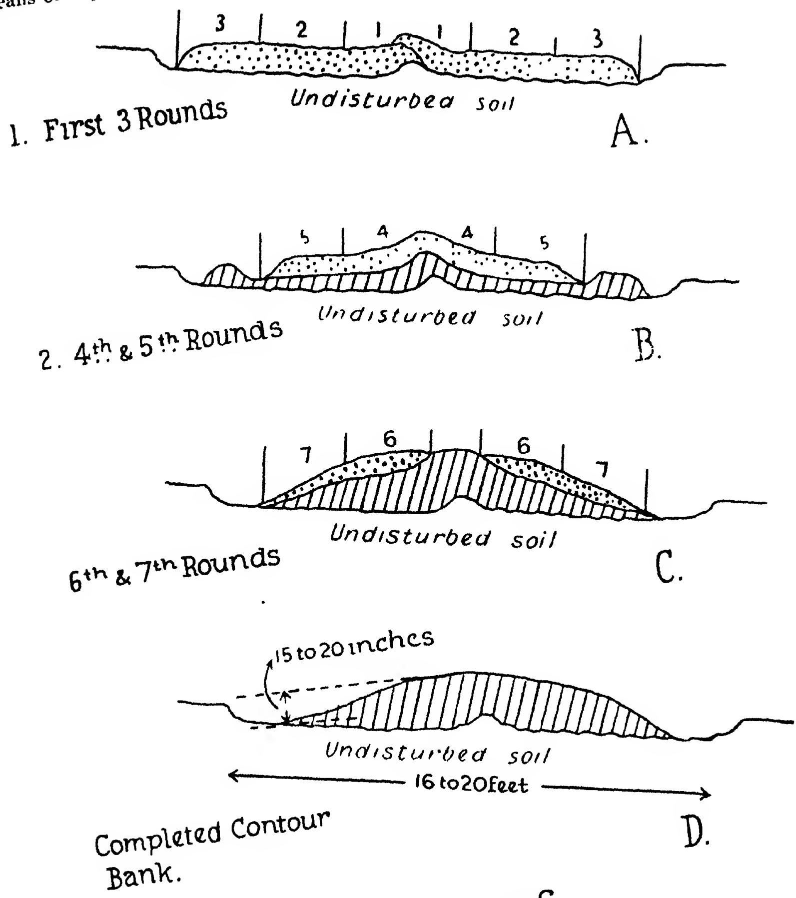


Figure 6.

Constructing broad base contour banks by means of a 4 or 5 furrow disc plough. Dotted area shows soil moved in the series of rounds being considered. Hachured area shows soil moved in the previous series of rounds.

6A. First series of 3 rounds. Note overlap in centre to form a bank.

6B. Second series of 2 rounds. The centre is again overlapped to raise the crown of the bank.

6C. Third series of 2 rounds commencing about 18 inches from the centre of the crown to broaden the crown. The second round clears and broadens the ditches.

6D. The completed contour bank. If desired a cultivator or set of harrows may be used to smooth out ridges and shoulders left by the plough.

Where the slope of the hill is greater than about 5 or 6 per cent., it is easier to move more of the soil from the upper side of the contour bank and when a 10 per cent. slope is being treated only one or two trips on the lower side will do

effective work. In such cases it is economical to construct the contour banks in the course of fallowing when all but the first trip are ploughed from the upper side. The other trips which would have been ploughed on the lower side are used for ordinary fallowing work further up the slope. On steeper slopes, too, it is necessary to give the banks a higher pitch to get the necessary height of crown.

The result should be a wide bank with a smooth, rounded top and a broad shallow drain on both the upper and lower sides. Water collecting in this drain will tend to soak in and thus add to the supplies of subsoil moisture. In the case

FIGURE 7.

Using a disc plough to build a broad base contour bank or Mangum terrace. (Conserve your Soil: Bank of N.S.W. circular.)

of heavy rainstorms the excess water is quietly moved in a broad shallow stream to the outlet and the damage resulting from water rushing over the surface and accumulating in gutters is avoided.

Testing the Contour Banks.

When the ploughing has been completed, the banks should be tested with the "level" to see that they are up to specifications. Apparent irregularities due to depressions, stony or gravelly bars, etc., must be examined so that low places may be filled in and high places cut down to allow unrestricted movement of water when necessary.

The slope along the bottom of the drain may be tested with the level as in pegging the line. To ascertain the height of the top of the bank above the drain it is suggested that one foot of the level be placed midway between these points and the other in the upper drain pointing the "level" down the slope. Measure the height to which this leg must be raised to bring the apparatus to the level, as in determining slope. Without altering the position of the upper foot, measure the drop to the top of the bank in a similar manner. In the event of the top of the bank being *higher* than the upper foot, this may be raised on a small mound of earth and the differences in height measured from this basis. The difference between these two measurements gives the height of the top of the bank above the upper drain.

Maintenance of the Contour Banks.

Contour banks require little attention but it is wise to inspect them carefully after the first heavy fall of rain to locate any weaknesses in construction and prevent damage by immediate attention. Once the banks have settled, it will be necessary to plough the earth to the centre occasionally. The height of the top of the bank above the drain will be reduced by the packing of the soil and spreading in the course of cultivation as well as by the accumulation of soil in the drain. Before this height has been so reduced that overflow is likely after heavy rains, the bank should be raised by a round or two with the plough to throw the soil to the centre.

The Value of the Contour Banks.

It is not intended to cite evidence to prove the value of the contour bank for soil conservation. Suffice it to say that it is universally recognised and experience in America has proved that they prevent erosion, conserve moisture and lead to improved crop yields. In answer to the question "Does it pay to use contour bank on slopes liable to soil erosion?" it may be stated that 6,000,000 acres of agricultural land have been treated in Texas alone. This is double the area sown to wheat in Western Australia.

Furthermore, measurements in Oklahoma have shown that, in one instance, the annual loss of soil per acre from a terraced area was 2.2 tons as compared with 64.1 tons from an unterraced area. Yields are reported to be from 20 to 40 per cent. higher on terraced areas.

Contour banks are not only of value because they prevent soil erosion but because they cause the moisture to soak into the ground. When stored in the subsoil, water is very valuable but it is a menace when moving uncontrolled over the soil surface.

Furthermore, contour banks do not interfere with the use of machinery, they may be constructed by any careful farmer with farm implements, and they are practically permanent once constructed. Failure of contour banks is always traceable to faulty work or design and not to any weakness in the system. Some farmers in New South Wales claim to construct banks at a cost of 10s. per acre. Generally, the cost would probably be greater but when combined with crop rotation and careful farm management, they represent a very sound investment wherever soil erosion is liable to occur.

ALL AUSTRALIAN PORKER AND BACONER CARCASE COMPETITIONS.

The Australian Meat Board advises that, during the present year, they will continue the competitions for export baconer and porker carcases which were successfully launched in December, 1937.

Very few entries were received last year from Western Australia, principally owing to the shortness of notice which was given prior to the closing date for entry to the competitions.

It is hoped that as many entries as possible will be submitted during the current year, and it will be noted that only three carcases are required, although five eligible pigs may be forwarded to the treatment works, from which the best selected three could be forwarded.

Should competitors desire any assistance in selecting the carcases to be forwarded, arrangements could be made by application to the Department of Agriculture for an officer to collaborate with the management of the works—through which the pigs are being shipped—in the selection of the carcases to be forwarded to London.

The following information regarding the conditions of the competitions are supplied by the Australian Meat Board:—

"The object of the competitions is to encourage the breeding of the right type of pigs for the export market and to advertise the Australian product overseas.

Conditions will be the same as last year. Entries for the next competitions must be delivered to works on or before October 15th next. Carcases will be judged in London on or about December 15th.

Each entry must be of three carcases, sired by a pure bred boar from a litter recorded by the Australian Stud Pig Breeders' Society. The three carcases may be selected from a maximum of five eligible pigs submitted.

Such particulars as age, breeding, feeds and methods of feeding and husbandry will be asked of entrants. The dam need not be pure bred but the breeding of the dam must be stated.

The weight range for entries in the porker class is from 60 lb. to 90 lb. and in the baconer class from 120 lb. to 160 lb. dressed weight and including heads in each case.

Only one entry of a particular breed or cross may be made by an individual entrant.

No entry fee will be charged but only those entries adjudged as of first grade export standard by a Commonwealth Inspector will be eligible to compete.

Competitors will be required to lodge their entry forms in the first instance with meatworks or bacon factories which they supply and to make arrangements with such works or factories for the delivery of carcases to a store in London as nominated by the Board. Payment for the pigs will be made by works in the usual way. The works will be reimbursed by the Board to the extent of ¼d. per lb. on baconer carcases as compensation for mutilation in judging.

Prizes to the value of £25 will be provided by the Board in each class. This amount will be divided up as follows—first £9, second £6, third £4, fourth £3, fifth £2, sixth £1. In addition a trophy valued at £10 10s. will be competed for in each class. First class certificates will be awarded to all entries scoring over 70 per cent. of total points and second class certificates to all scoring from 60 to 70 per cent. of the total.

Entry forms may be obtained from the office of the Australian Meat Board, 401 Collins street, Melbourne, from the Veterinary Officers of the Department of Commerce in each State, from the Department of Agriculture, Western Australia, from the Secretaries of the State Branches of the Australian Stud Pig Breeders' Society and from meatworks or bacon factories handling export pigs.—G. K. Baron-Hay.

ERRATA.

Page 325, line 3, column 10.—"Lansdowne Cream Lass," insert 393.33 lbs. in place of 387.57 lbs.

ASSOCIATIONS FOR THE IMPROVEMENT OF DAIRY HERDS IN WESTERN AUSTRALIA.

REPORT FOR YEAR ENDING 30th APRIL, 1938.

G. K. BARON-HAY, Superintendent of Dairying, and
R. A. PAUL, Agricultural Adviser.

During the autumn of 1937 early rains gave promise of a good season which was sustained throughout the winter period and spring months, the general result being favourable conditions for the growth of pasture and, consequently, production of dairy products throughout the State.

The average production of those cows under test in the scheme is shown in Table 1 below and includes the productions of all cows which were under test for three months or over.

TABLE 1.

Average Production per Cow.

No. of Herds.	No. of Cows.	Milk.	Test.	Butter-fat.
		gals.	%	lbs.
393	10,033	486	4·59	223·07

This average production taken in conjunction with the average price of butter fat, approximately 15d. per lb., during the year should enable an efficient dairy farmer to conduct his business so as to yield a net profit.

While this increased yield may be due, in part, to seasonal conditions, Table 2 which shows the steady improvement each year since grade herd recording was initiated in 1933-34 indicates that testing is a great factor in effecting and then maintaining increased yields.

TABLE 2.

Average Production per Cow, 1934–1938.

Year.	No of Cows.	Milk.	Test.	Butter-fat.
		gals.	%	lbs.
1933–34	4,038	415	4·35	180·6
1934–35	4,088	456	4·56	207·8
1935–36 † ...	4,590	459	4·51	207·3
1936–37*... ...	9,115	434	4·53	196·7
1937–38† ...	10,033	486	4·59	223·1

* 9 new units. † 1 new unit.

In Table 2 above it will be noticed that 1936-37 there was an apparent reduction in yield from that of the previous year. This, however, can be explained in part by the comparatively unfavourable season, but this in itself is not a sufficient cause. The real reason is that in that year the number of cows under test was more than double, owing to the formation of nine new units, the average production of which was 181.4 lbs. butter fat. It is rather interesting to note that this average production is almost identical with the average production of the first eight units which commenced operations in 1933-34 and is a guide to the average production of the cows which are not under test throughout the dairying districts.

Generally, the average production of new units approximates from 180 to 190 lbs. butter fat, but rapidly increases after herd recording commences.

The nine units which had been under test during 1936-37 for more than one year averaged 210 lbs. butter fat per cow, thus maintaining production in spite of the unfavourable season.

PRODUCTION PER COW IN EACH UNIT.

The average production per cow in each unit is shown below in Table 3, and it will be noticed that in every instance there has been an increase in production over that for the previous season.

TABLE 3.

Average Production of Cows in each Unit.

Unit.	Herds.	Cows.	Heifers.	Milk.	Test.	1937–38. Butter-fat.	1936–37. Butter-fat.
	No.	No.	%	lbs.	%	lbs.	lbs.
A.—Donnybrook	20	433	22	5,276·60	5·20	275·18	235·79
B.—Serpentine ...	18	396	13	5,523·76	4·29	236·93	215·92
C.—Cookernup ...	23	745	21	5,257·77	4·30	230·83	195·23
D.—Harvey ...	19	545	21	4,800·00	4·58	219·69	216·08
E.—Brunswick ...	21	606	16	5,375·00	4·71	253·15	231·32
F.—Dardanup ...	22	749	15	4,512·00	4·31	192·98	180·73
G.—Capel ...	18	689	17	5,164·00	4·31	222·66	209·96
H.—Balingup ...	23	684	21	5,181·28	4·69	243·06	212·78
I.—Forest Grove...	22	505	19	4,625·00	4·58	211·82	202·43
J.—Pemberton ...	20	334	12	4,421·72	4·62	204·49	180·20
K.—Rosa Brook	25	515	12	4,744·49	4·72	224·33	195·98
L.—Vasse	23	489	31	4,802·61	4·78	229·59	...
M.—Manjimup ...	20	490	14	4,486·00	4·77	214·28	178·80
N.—Uduc	17	409	19	4,937·69	4·38	216·08	187·66
O.—Benger ...	18	522	12	5,181·40	4·58	233·25	208·14
P.—Pinjarra ...	21	533	10	4,564·93	4·63	210·01	162·66
Q.—Greenbushes ...	23	583	12	4,507·04	4·82	217·35	170·47
R.—Brookhampton	20	414	23	4,413·00	4·78	211·13	180·43
S.—Albany ...	20	392	18	4,225·00	4·39	185·46	161·95

In comparing productions of cows in different districts, it has been noticed generally that, where dairy farming is not the principal activity on a farm but is incorporated with other forms of agriculture and, in particular, beef-raising and sheep production, there is a tendency for the average yields to be depreciated. This is not necessarily the case as is exemplified by the high average production of 275 lbs. butter fat per cow in the Donnybrook district, but in this instance dairy farming may be regarded as the principal activity during nine months of the year, whilst orcharding, particularly in the packing period, precludes dairy farming during the dry months. With sheep-raising, however, adequate provision does not exist at present, particularly as regards fences, and, where dairy cows and sheep are run on the same farm, unless cows can have access to the pasture first and then be followed up by sheep, low yields seem to be the result.

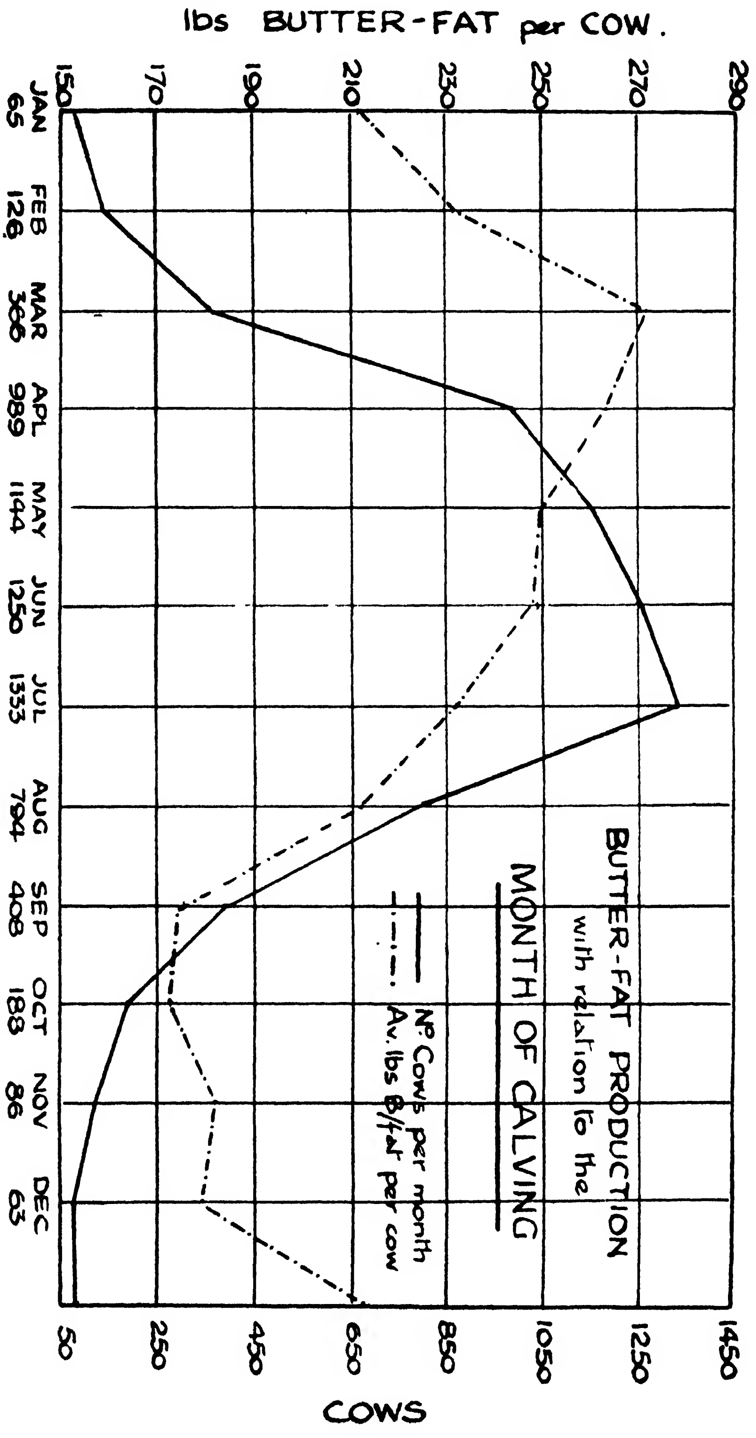
It is gratifying to notice from Table 3 that, in a number of newly developed districts in the South-West, the average production of cows is quite good, such as at Forest Grove, Rosa Brook, Vasse, Manjimup, and Greenbushes. The yields in the Albany district are disappointing but improving, and it is believed that by improvement in management, particularly regarding fodder conservation and controlling the lactation periods of cows, the yields of these cows can be raised considerably.

OPTIMUM LACTATION PERIOD.

An investigation into the records of cows in relation to the month in which they calve has been continued, and the results of the 10,000 cows under test this year corroborate those for previous seasons.

In the graph below it will be noticed that peak production was given by those cows calving during March and April with but slight reduction in yield for those calving during May and June.

In previous years, peak production has been given by cows calving during April with only a slight reduction during May and June.


lbs BUTTER-FAT per COW.
150
170
190
210
230
250
270
290
JAN 65
FEB 126
MAR 366
APL 989
MAY 1144
JUN 1250
JUL 1333
AUG 794
SEP 408
OCT 188
NOV 86
DEC 63
BUTTER-FAT PRODUCTION
with relation to the
MONTH OF CALVING
Nº Cows per month
Av. lbs B/fat per cow
50
250
450
650
850
1050
1250
1450
COWS

During 1937-38 excellent rains fell in February and early March with sufficient further falls to maintain the growth of pasture thus germinated, which would account for the higher yields during March.

Present results, therefore, confirm previous advice that, for maximum production, early calving is essential, preferably during April, May, and not later than June. September to December are definitely periods during which an endeavour should be made to prevent cows commencing their lactation period.

The position as far as the various units are concerned regarding the percentage of cows which commenced lactation during this desirable period of April to June is shown in Table 4 which, however, also includes cows which commenced lactation during July.

It will be noticed in comparing the yields in columns 3 and 4 that the butter fat production of cows which calved early in the season (column 3) is in every instance in excess of the general unit average, and that in some instances the low average yield is in great part due to the small percentage of cows commencing their lactation period early in the season. For instance, in the Dardanup district approximately one-third of the cows which calved early in the year produced 244 lbs. butter fat, whilst the unit average was only 193 lbs.

TABLE 4.

Percentage of Cows completing Nine Months' Test.

1. Unit.	2. Cows.	3. Butter-fat.	4. Unit Average Butter-fat.
	%	lbs.	lbs.
A.—Donnybrook	90	282·09	275·18
B.—Serpentine	73	255·88	236·93
C.—Cookernup	48	247·63	230·83
D.—Harvey	44	228·59	208·31
E.—Brunswick	57	262·69	253·15
F.—Dardanup	29	244·29	192·98
G.—Capel	78	227·68	222·66
H.—Balingup	79	251·35	243·06
I.—Forest Grove ...	70	224·55	211·82
J.—Pemberton	66	222·77	204·49
K.—Rosa Brook ...	45	261·32	224·33
L.—Vasse	59	241·57	229·59
M.—Manjimup	65	220·07	214·28
N.—Uduc	57	231·18	216·08
O.—Benger	95	239·67	233·25
P.—Pinjarra	64	227·82	210·01
Q.—Greenbushes ...	94	226·69	217·35
R.—Brookhampton ...	84	219·43	211·13
S.—Albany...	66	197·75	185·46

WHOLE MILK PRODUCTION.

In a number of units where the percentage of cows calving early is low, it is claimed that this is necessary as, in these areas, milk is being produced for consumption as whole milk and it is necessary to calve cows more or less evenly throughout the year in order to maintain an even supply, as for instance in the Cookernup, Harvey, and Brunswick areas. In these areas the difference between the unit average and the production of cows calving during the early autumn is not as great as might be expected, because these districts have the advantage of irrigation which assists greatly in maintaining summer production.

Even under these conditions, however, it will appear from information gathered each year and shown in the above graph that, even for the supply of whole milk, it may be undesirable to commence lactations during September, October, November, and December. During these months a supply of milk can be

maintained by cows which calve early in the autumn, owing to the great flush of pasture normally available, and summer production should be provided from cows which commence their lactation period late in December, January, and February. By this practice a higher general production for the whole herd would be obtained.

It is sometimes claimed that, as herd recording is aimed particularly at raising the butter fat production of cows, those farmers interested in whole milk production would not receive any appreciable benefit from testing their herds. In Tables 2 and 3, however, it will be noted that higher butter fat productions are coupled with higher milk yields and that, since the inception of herd recording, the average butter fat test has been 4.4 per cent. to 4.6 per cent., while milk yields have increased consistently from 415 to 486 gallons per cow, and that in some districts where whole milk production is the vogue, as at Serpentine, Cookernup, and Brunswick, the milk production is above the average owing to concentration of breeds other than those for high butter fat production. In these districts the milk yield is respectively 552 gallons, 526 gallons, and 537 gallons per cow per lactation period, including those cows which calved at relatively unprofitable periods of the year. These yields under such conditions which require a minimum of hand-feeding with purchased concentrates should make whole milk production considerably more profitable than butter fat, after making due allowances for cost of deliveries and the reduced yield owing to maintaining a constant supply throughout the year.

CONTROL OF LACTATION PERIOD.

As pointed out in the annual report for the year 1936-37, success in the control of lactation periods with dairy cattle calls for careful management, particularly as regards—

1. Prevention and treatment of disease.
2. Provision of suitable fodder.
3. Control of the dairy sire.

1. *Prevention and Treatment of Disease.*

Prevention undoubtedly is preferable to cure where any disease is concerned, and, in a dairy herd, there is only one sure means of prevention and that is to start with a clean herd and then breed all the replacements that are required.

Many dairy farmers make a practice of buying cows in profit and selling later in the season as cows "dried off," the herd being again replenished by further buying. It is in such herds that diseases are usually found, the three worst being mastitis, contagious abortion, and vaginitis. The two latter diseases can be controlled definitely by avoiding the introduction of infected animals into the herd, as, without the presence of the specific germ causing the disease, an outbreak is impossible.

The writers are aware of many instances where, for a number of years, farmers' herds have not suffered from any of these diseases, and it is ascribed to the fact that these farmers have refrained from buying cows during this period.

The treatment of these diseases is described in detail in the Bulletin "Common Stock Diseases and Their Treatment" by A. McK. Clark, Chief Veterinary Surgeon, and which may be obtained free from the Department of Agriculture.

Where, however, owing to one cause or another, a large proportion of the herd has failed to conceive normally and is thus calving "out of season," the problem is "what means should be adopted to again bring these cows back to early autumn calving."

Usually cows are mated in the third or fourth month after calving, as, if conception occurs at an earlier period, the lactation is shortened which is undesirable, but, even if service should occur one month after calving, the date of com-

mencing the lactation can only be "brought back" by two to three months which is generally quite insufficient, and thus several years elapse before these "out of season" cows are again calving at a desirable time of the year, i.e., April to June. Some dairy farmers even go to the expense of selling such cows, after the first flush of their lactation period, rather than persevere for a number of years to bring them back to the correct month of calving.

Another method which has been tried by several farmers, and, in their opinion, is reported to be profitable, is to prevent those cows calving, say, from September onwards from being served with the bull, and to milk them through the summer and then through the following autumn, mating these cows normally with the remainder of the herd in July and August. It is maintained that, while such cows may not yield their maximum during the ensuing flush season, they do increase considerably over their summer production once green feed is available, and they are "brought back" to a normal calving date within one year.

With a view of obtaining definite information regarding this, a number of such "out of season" cows are being maintained under test throughout the double milking period, with a view to ascertaining whether such a system is profitable. It is hoped that information on this point will be available at the end of the present testing year 1938-39.

2. *Provision of Suitable Fodder.*

The provision of suitable fodder during the summer and early winter months is a problem that recurs annually and requires careful planning and forethought. Unless, however, there is ample fodder available for maintaining cows in prime condition during the summer months and then for continued feeding after the lactation period commences until ample pasturage is available, there is little object in arranging for early calving.

During the year under review, the quantity of fodder conserved was more than usual, due almost entirely to the nature of the season. Every effort, however, should be made to conserve all the fodder cows are likely to require, and the type of fodder to be conserved may vary with the season and from farm to farm. The principles governing conservation, however, remain the same.

(1) Ample fodder must be conserved and at least 2½ tons of fodder per milking cow calculated as hay is desirable.

It is found that those farmers whose herds are among the highest producing groups conserve more than this per head.

The highest producing herd in the scheme this year, owned by Mr. A. M. Patterson of the Vasse, consumed approximately double this quantity during the year.

(2) A second consideration is the type of fodder to conserve, which will vary with the situation of the farm. The basic consideration, however, is that cows require succulent food for the production of milk.

In irrigated districts, therefore, hay probably would be preferable for feeding with irrigated green pasture and also during winter months. On unirrigated farms, unquestionably silage should receive first attention.

The consumptive capacity of cows is not generally recognised, and instances have come under the writer's notice where, although ample fodder has been conserved, this is being given to cows in daily quantities considerably less than the cows require.

During the summer months a cow will consume 50 to 60 lbs. silage per day or 20 to 30 lbs. of good meadow hay, and it is suggested that feeders should weigh this quantity of fodder on one occasion when it is believed some surprise would be evinced at the bulk which such a weight of fodder entails.

HERDS GROUPED ACCORDING TO PRODUCTION.

In Table 5 below an indication of the general uplift which is occurring in the production of herds which have been tested for a number of years is clearly shown.

TABLE 5.

Herds Grouped according to Production.

Year.	Pounds of Butter-fat per Head.							
	Over 400.	350–400.	300–350.	250–300.	200–250.	150–200.	100–150.	Under 100.
	%	%	%	%	%	%	%	%
1933–34 ...	...	...	1·31	3·93	20·3	53·55	18·3	2·61
1937–38 ...	·26	·77	4·07	19·34	45·29	26·46	3·55	·26

It will be noted that, whereas in the first year of testing in 1933-34 nearly three-quarters of the herds under test yielded an average production of less than 200 lbs. butter fat, at the end of the fifth year of testing these low producing

A typical high-grade Jersey cow in Mr. A. Tomerini's herd, Balingup. Note absence of horns. This herd of 32 cows averaged 308.3 lbs. butter fat per cow.

herds had been reduced to 30 per cent., which, however, is still in excess of what may be regarded as satisfactory. It is believed that in a normal season, and with careful management, there should be no herds falling in those groups producing less than 200 lbs. butter fat per cow.

In the 200-250 lb. butter fat group it will be noticed that the percentage of herds has increased from 20 per cent. to 45 per cent., while the number of herds producing over 250 lbs. butter fat has gone up from 5.2 per cent. to 24.4 per cent.

COWS GROUPED ACCORDING TO PRODUCTION.

In Table 6 below the productions of mature and junior cows are given in various production groups.

TABLE 6.

Cows Grouped according to Age and Production.

(All Cows Tested less than 90 days excluded.)

Age Class.	Groups according to Butter-fat Production (lbs.).								Total Cows.
	Over 600.	500–600.	400–500.	300–400.	200–300.	150–200.	100–150.	Less than 100.	
	%	%	%	%	%	%	%	%	
Mature ...	0·04	0·13	2·15	18·88	48·42	18·00	9·17	3 21	6,311
Junior* ...	...	...	0·46	6·13	39·48	27·34	17·51	9·08	3,277

* Cows under 3 years of age at calving.

As would be expected, the production of junior cows, i.e., cows which commenced their lactation period before they were three years old, is less than that for mature cows. It is surprising, however, to notice that for 1937-38 no less than 34 per cent. of cows which were tested for more than three months fall in the junior class, a proportion which is unduly high and would tend to reduce the profit from herds. This proportion also was the same as for the previous year and indicates that herds are in the process of being built up consequent on the development of greater areas of pasture.

A HEAVY PRODUCER.

"Chrissie," a Fresian Jersey cross cow owned by Mr. F. Byrd, Harvey, produced 14,841 lbs. milk, 4.52 per cent. test, 671.96 lbs. butter-fat, in her last lactation.

When the herd has been increased to the number which is considered suitable for any farm, and taking the average working life of a cow as six years, the percentage of heifers in herds under normal conditions need not exceed 17 per cent.

or 1 heifer for every six cows. A herd of cows built up in this proportion would average a higher production than when it is necessary for any reason to include a larger percentage of heifers.

PROVED BULLS.

Following the practice which was inaugurated last year, a further list of proved bulls having six or more daughters that have been tested and have produced over 200 lbs. butter fat has been compiled and is given below in Table 8.

TABLE 8.

Bulls with Six or more Daughters which have Produced not less than 200 lbs. Butter-fat.

Sire's Name	No Daughters Tested	lbs Butter-fat		Owner's Name	Unit	Age of Bull (if still living).
		Average Production.	Average Production with age allowances			
JERSEY		lbs.	lbs			Years.
White Fern of Clover Glen	7	441	441	A. M. Patterson	Vasse	
Melrose Gratter	6	373	373	R. C. Williams	Greenbushes	15 D.
Moorlands Digger	6	359	368	R C. Williams	Greenbushes	9
Fowler's Reward of Capel	6	346	354	C. A McCormack	Capel	
Grass Vale Montrose West	10	338	338	E. J Manning	Udue	11
Grass Vale Fowler's Twylish	15	270	336	J Salerian	Cookernup	4
White Rocks Eddy	6	270	317	R A. Clifton	Brunswick	6 D.
Moorlands Don	14	298	312		Harvey	8
Ventonia Elvera's Noble	6	232	296	Mrs. D B. Rose	Brunswick	5 D.
Mokine Hero	8	286	295	F. Richards	Dardanup	13 D.
Euroch Moonlight	6	276	276	J. Angell	Rosa Brook	9
Garden Hill Sportsman	10	234	264	R. O Hayward	Harvey	13
Travalgan Air Chief	17	239	253	T. M Smith	Pinjarra	8 D.
Moorlands Dago	11	243	246	O F. H Bowles	Pinjarra	9
Campanile Lad	11	238	246	A Jones	Brookhampton	10
Coronation Glenerin	8	194	232	R E. Runciman	Brookhampton	
Juadine Philanderer	20	230	230	R O. Hayward	Harvey	12
Colmyn Bright Star	15	175	209	T. B. Davidson	Balingup	7
AUSTRALIAN ILLAWARRA SHORTHORN						
Hillview First Hope	6	298	364	P Fitzpatrick	Cookernup	6
Maxicar Millions	8	293	356	E Brockman	Balingup	7
Sarsden Laddie	7	290	352	L C Winduss	Cookernup	10
Tipperary Camelia II's Re-Echo	6	282	350	C A. Wickham	Cookernup	6
Wooroloo Masher	6	301	317	A L Johnson	Udue	13
Bright's Bill of Berry	7	298	298	L. C. Winduss	Cookernup	17
Glanavon Darius	9	249	296	P. MacNeill	Udue	6
Wooroloo Bobs IV.	6	238	293	R R Graham	Pemberton	6
Sarsden Monarch	12	283	289	A. E Taylor	Harvey	11
Summerlea Marquis	10	269	289	L A Mitchell	Brunswick	7 D.
Tipperary Melba's Re-Echo	6	204	254	C L Clarke & Co	Brunswick	11
Nyrup Mercom	6	180	239	F. Reeve	Brunswick	6
Star of Wongong	15	229	232	M G. Baker	Brookhampton	14 D.
Sarsden Lad 10th	8	199	227	A. E Taylor	Harvey	4
Lowden Knight	11	211	211	E. Trevena	Brookhampton	D.
GUERNSEY.						
Brookfields Prince	7	313	338	A R Testar	Udue	7
Muresk Diomede	6	224	277	Eastman & Son	Brookhampton	7
RED POLL						
Aberlechan George	9	236	249	J Flynn & Sons	Dardanup	9

In the Journal of Agriculture, December 1937, a list containing 53 proved bulls was published, and Table 8 contains the names of a further 37 bulls and the average production of their daughters, together with the names of the owners of the bulls. Of these bulls, nine are known to be dead, while a further nine have reached an age which probably has resulted in their sterility.

The average age of these bulls is nine years, so that, except for a few of the bulls the first heifers of which have been under test and the bulls are, therefore, about five years of age, there is little prospect of the animals in this list producing a great number of further offspring.

In view of the comparative scarcity of these proved bulls, it is hoped that all daughters of these sires, which are from cows testing over 250 lbs. butter fat and, therefore, are eligible for identification under the calf marking scheme, will be marked and registered. It is by this means that the average production of all cows in Denmark (Europe) has been increased from 85 lbs. butter fat per cow since 1885 to the remarkably high average of 257 lb. butter fat per cow for all cows in the kingdom.

HERDS GROUPED ACCORDING TO PRODUCTION AND SIZE.

The following four Tables, Nos. 9 to 12, which give the productions of leading herds grouped according to their size, yield interesting information.

In Table 9 are shown those herds in order of merit producing over 260 lbs. butter fat and consisting of less than 20 cows. It will be noted that these smaller herds, which are in districts producing butter fat only, are comprised mainly of the Jersey or Guernsey breed, one herd only being Illawarra Shorthorn and one herd Friesian. Eight herds produced over 300 lbs. butter fat compared with only four herds the previous year, whilst twenty-four produced over 260 lbs. compared with only fourteen herds the previous year, and is indicative again of the general uplift in production.

TABLE 9.

GROUP I.—HIGH PRODUCING HERDS OF LESS THAN 20 COWS.

(In order of Merit.)

Owner.	Association.	No. of Cows.	Breed.	Butter-fat.
				lbs.
R. L. Maidment	Capel	10	A.I.S.	366
O. Foan	Donnybrook	19	Jersey ...	359
P. Proctor	do.	12	do. ...	350
L. A. House	Pinjarra	12	do. ...	346
A. C. Frost	Donnybrook	14	do. ...	311
W. Darnell	Rosa Brook	19	do. ...	305
J. McEwan	Cookernup	17	do. ...	304
L. Temple	Harvey	14	do. ...	303
C. Piggott	Brunswick	14	do. ...	296
P. J. Fuller	Donnybrook	10	do. ...	294
Mrs. A. Margeroson ...	Manjimup	9	Guernsey ...	284
H. L. Newman	Albany	19	Jersey × Shorthorn	282
W. J. Morgan	Manjimup	10	Jersey ...	279
F. George	Rosa Brook	17	do. ...	278
D. Bendotti	Pemberton	16	Guernsey ..	277
Mrs. M. Abbott	Pinjarra	15	Jersey	276
A. Clifford & Sons	Donnybrook ..	17	do. ..	275
R. M. Davies	Manjimup	18	do. ..	274
R. Cain	Donnybrook ..	14	do.	274
E. J. Kemp	Brookhampton ...	9	do. ...	268
G. Simmons	Dardanup	15	do. ...	268
Bell Bros.	Brunswick	14	Friesian ...	267
Mrs. E. Taylor	Vasse	16	Jersey ...	260
E. Hough	Forest Grove ...	18	do. .	260

In Table 10 below, the improvement is even more marked in herds from 20 to 40 cows. The leading herd owned by Mr. A. M. Patterson, Vasse, was the first herd to average over 400 lbs. butter fat without any allowance under the grade herd recording scheme. The success of this herd was due to careful management, the liberal use of conserved fodder, and attention to the necessity of early autumn calving.

Mr. Patterson also has been fortunate with the Jersey bull which he owned some years ago, the seven daughters of which now in the herd averaged 441 lbs. of butter fat.

No less than 13 herds in this group of medium size herds exceeded 300 lbs. butter fat per cow compared with only five the previous year, and 26 herds exceeded 280 lbs. butter fat compared with only 10 the previous year.

TABLE 10.

GROUP II.—HIGH PRODUCING HERDS OF FROM 20-40 COWS.

(In order of Merit.)

Owner.	Association.	No. of Cows.	Breed.	Butter-fat.
				lbs.
A. M. Patterson	Vasse	24	Jersey	406
C. J. Cunningham ...	Donnybrook	21	do. ...	353
S. Bowers	Brunswick	26	do. ...	338
W. J. Sears	Donnybrook	24	do. ...	332
F. G. Williams	Pinjarra	26	do. ...	319
E. J. Kentish	Serpentine	32	do. ...	319
S. C. Maidment	Balingup	29	Jersey × Shorthorn	313
S. Johnston	Vasse	24	Jersey ...	312
G. S. Blaikie	Rosa Brook	21	do. ...	311
A. Tomerini	Balingup	32	do. ...	308
F. Heywood	Greenbushes	25	do. ...	307
L. Westcott	Serpentine	22	A.I.S.	306
T. Tyrell	Dardanup	22	Jersey ...	303
T. B. Stanley	Benger	23	A.I.S.	298
R. A. Clifton	Brunswick	21	Jersey ...	296
M. Brennan	Balingup	20	Jersey × Guernsey	296
S. Carlsson	Benger	26	Jersey ...	295
W. K. Barnes	do.	28	Shorthorn × Jersey	293
Ellis Bros.	Brunswick	32	A.I.S.	292
A. Millar	Rosa Brook	25	Jersey ...	292
T. G. Hutton	Capel	31	Friesian ...	291
S. H. Fry	Benger	38	A.I.S.	285
D. H. Bell	Vasse	25	Jersey × Shorthorn	284
T. H. Ellis	Balingup	23	Jersey ...	284
D. Strachan	Dardanup	24	do. ...	282
M. Kilrain	Manjimup	25	Guernsey ...	281

In Table 11 is given a list of those herds of from 41 to 60 cows producing more than 229 lbs. butter fat per cow. High productions in these large herds is particularly difficult to attain and equally difficult to maintain.

The production of the herd owned by Mrs. D. B. Rose in the Brunswick unit is interesting as showing the results which may be obtained by the use of the information supplied from the scheme. The following figures indicate the increase in production during the three years that this herd has been under test:—

Year.	Number of Cows.	Average Butter-fat.	Total Butter-fat.
		lbs.	lbs.
1935–36	70	185.1	12,957
1936–37	62	210.84	13,072
1937–38	51	293.94	14,991

It will be seen that the average butter fat production of the herd has been raised by nearly 60 per cent. during these three years. During the last year of

testing when the herd comprised 19 less cows, the total butter fat produced was 2,034 lbs. in excess of that given during the first year of testing. During this period, over 30 cows have been culled and replaced by stock bred on the farm.

Over-stocking probably resulted in the low yield during 1935-36, and special care is being taken to prevent this recurring.

Hauling subterranean clover to the silage trench. Mr. J. Littlefair, Pemberton.

Another herd which has shown a marked increase in production is that owned by Mr. R. C. Williams, Bridgetown. The average production of this herd has been raised by 78 lbs. during the two years' testing period.

In this group of herds also, the average production shows considerable increase over that for the previous year. Six herds averaged over 270 lbs. butter fat, whereas in this class of 41 to 60 cow herds the previous year, the highest producing herd only yielded 261 lbs. butter fat per cow.

TABLE 11.

GROUP III.—HIGH PRODUCING HERDS OF FROM 41–60 COWS.

(In order of Merit.)

Owner.	Association.	No. of Cows.	Breed.	Butter-fat.
				lbs.
Mrs. D. B. Rose ...	Brunswick	51	Jersey ...	294
R. C. Williams	Greenbushes	43	do. ...	293
P. Fitzpatrick	Cookernup	60	A.I.S.	284
A. & A. E. Millar ...	Forest Grove ...	43	Jersey ...	278
D. Scott	Balingup	43	do. ...	275
J. V. Doley	Serpentine	45	A.I.S.	270
C. Somerset	Balingup	52	Friesian × Jersey	257
W. Irwin-Flannagan ...	Capel	44	A.I.S.	248
H. P. Fry	Benger	44	do.	248
C. A. McCormack ...	Capel	41	Jersey ..	243
J. H. Brett	Dardanup	51	do. ...	235
K. H. Clifton	do.	42	Guernsey ...	229

In Table 12 the five leading herds of over 60 cows is given in order of merit, the productions of all being meritorious when the size of the herds are taken into account.

TABLE 12.

GROUP IV.—HIGH PRODUCING HERDS OF OVER 60 COWS.

(In order of Merit.)

Owner.	Association.	No. of Cows.	Breed.	Butter-fat.
				lbs.
J. Salarian	Cookernup	66	Jersey	266
G. M. Dempster	Benger	61	do.	243
J. P. Norton	Capel	81	A.I.S.	237
J. Neil	Cookernup	64	Jersey × Shorthorn	231
C. A. Wickham	do.	69	A.I.S.	225

Each year a list of the 20 leading cows in the scheme is published in the form shown in Table 13 below. This is the first year during which the production of individual cows has exceeded 600 lbs. butter fat for the lactation period, and two cows, namely, "Belle"—a Jersey cow owned by Mr. C. Piggott, Brunswick, with a production of 641 lbs. butter fat, and "Gentle"—a Shorthorn cow owned by Mr. R. L. Maidment, Capel, with a production of 620 lbs. butter fat, have broken new ground. The average production of these 20 cows was 526 lbs. butter fat compared with an average of 472 lbs. per cow for the 20 leading cows during the previous year, and indicates that, with management and the inherent capacity of the cow for production, yields comparable with those in other countries can be obtained in Western Australia.

TABLE 13.

TWENTY LEADING COWS—ALL UNITS.

Owner.	Unit.	Name of Cow.	Breed.	Tattoo.	Test.	Butter-fat.
					%	lbs.
C. Piggott	Brunswick	Belle	Jersey	E.Ɖ. 1	4 99	640·95
R. L. Maidment	Capel	Gentle	Shorthorn	G.W. 8	4·84	619 74
C. Foan	Donnybrook	Poppy	Jersey	A.L. 20	5·75	577·97
R. C. Williams	Greenbushes	Maggie VI.	do.	Q S. 23	5·07	547 15
Ellis Bros.	Brunswick	Jenny	Shorthorn	E.B. 10	5·21	545 81
W. Darnell	Rosa Brook	Dolly	Jersey	I U. 14	5·05	545 64
T. Jamieson	Capel	Betty II.	Shorthorn	G.S 1	5·75	541 03
F. Byrd	Harvey	Chrissie	Friesian ×	D.T. 18	4·26	531 81
T. Jamieson	Capel	Pickles	Shorthorn × Jersey	G.S. 8	5·72	531 54
Do.	do.	Melba	do. do.	G.S. 12	6·08	517 44
A. M. Patterson	Vasse	Katy	Jersey	L.B. 3	5·34	514·10
A. Tomerini	Balingup	Maghy	do.	H.J. 17	5·99	508·86
S. Bowers	Brunswick	Coral	do.	E.F. 33	5·49	502·62
A. M. Patterson	Vasse	Lanky	do.	L.B. 8	4·75	494·42
Do.	do.	Topsy	do.	L.B. 9	5·35	492·02
L. Westcott	Serpentine	Maggie	Shorthorn ×	B.G. 15	4·91	487 11
P. Proctor	Donnybrook	Dainty	Jersey	A F.* 13	6·72	486 54
M. Kilrain	Manjimup	Bella	Guernsey	M.C. 6	5·60	483 10
P. Fitzpatrick	Cookernup	Flossie	Shorthorn × Jersey	9C. 10	5·40	477·25
W. Darnell	Rosa Brook	Tiny	Jersey	I.U. 13	5 90	475 00

* F reversed.

The "Sunny-West" Cup presented by the South-West Co-operative Dairy Farmers Ltd., to the owner of the four highest producing cows in any herd tested under the grade herd recording scheme has again been won by Mr. T. Jamieson of Capel. It is pleasing to record that these cows did not receive concentrates other than those which can be grown on the farm.

The records of these cows are as follow:—

Name of Cow.	Milk.	Butter-fat.
	lbs.	lbs.
Betty 2nd	9,393	541.03
Pickles	9,285	531.54
Melba	8,502	517.44
Stella	8,573	463.01
Average	8,938	513.25

It also is interesting to notice that three of these same cows were also in Mr. Jamieson's team of the winning four the previous year, and that in each instance their productions are considerably higher during the year under review.

Ample fodder conservation on Mr. J. Littlefair's farm, Pemberton.

While the improvement which has been recorded is no doubt in part ascribable to the good season which has been experienced, herd recorders report an increased attention by members to the utilisation of the information given each month and that the high yields are in no small part due to greater conservation of fodder which was fed during early autumn months, and in some areas the sowing of early oats for grazing.

There is also a tendency for the sub-division of large paddocks, so that they may be utilised for rotational grazing, and, with this, the practice of using larger applications of superphosphate for topdressing is developing.

AVERAGE PRODUCTION OF ALL UNITS.

The production of all units which were under test during 1937-38 is given in Table 14 below.

TABLE 14.

Donnybrook "A."	No. of Cows.	Butter-fat Average.	Serpentine "B."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
O. Foan ("L")	19	358·83	E. J. Kentish ("K") ...	32	318·63
C. J. Cunningham ("H")	21	353·40	L. Westcott ("G") ...	22	305·96
P. Proctor ("F*") ...	12	350·62	J. V. Doley ("A") ...	45	269·54
Herd A	24	331·66	Herd T	35	257·33
" C	14	311·38	" D	20	248·55
" W	10	294·38	" H	21	248·10
" E*	33	277·98	" U	14	246·41
" G*	17	275·33	" M	12	235·78
" A2	14	273·78	" V	30	234·65
" E	32	272·06	" O	31	231·91
" D	27	271·51	" L	8	231·32
" F	27	266·96	" S	28	203·02
" A*	24	253·75	" N	6	202·86
" Z	36	247·15	" I	25	200·11
" C*	21	243·52	" E	13	199·80
" K	28	241·59	" C	15	172·29
" B*	10	240·47	" X	14	171·12
" P*	7	236·20	" P	25	149·71
" X	23	222·04			
" L*	20	189·11			

* Letter reversed.

Cookernup "C."	No. of Cows.	Butter-fat Average.	Harvey "D."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
J. McEwan ("CY") ...	17	304·13	L. Temple ("C") ...	16	303·31
P. Fitzpatrick ("9C") ...	60	283·85	Mrs. A. Eckersley ("E")	26	262·34
T. Twaddle ("J*") ...	20	279·51	E. Holthouse ("AC") ...	19	259·34
Herd B	35	271·84	Herd AL*	26	253·01
" CS	66	266·25	" T	32	239·46
" D*	21	256·50	" N	30	238·54
" R*	11	247·04	" P	42	230·80
" P*	22	245·69	" AO	14	228·51
" L	31	241·03	" AD	26	207·31
" E*	26	235·71	" R	30	206·10
" T	28	232·78	" AG	16	205·35
" 7C	64	231·50	" G	30	201·91
" P	34	231·18	" I	36	198·80
" Q	37	229·04	" A	41	196·26
" 8C	22	228·74	" AB	24	187·42
" F	69	224·83	" W	26	185·94
" T*	16	222·89	" AM	38	181·90
" 2C	13	210·48	" AN	15	175·72
" J	44	197·81	" V	58	132·47
" G	31	188·43			
" D	34	184·34			
" W	11	175·42			
" F*	33	153·79			

* Letter reversed.

TABLE 14—*continued.*

Brunswick "E."	No. of Cows.	Butter-fat Average.	Dardanup "F."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
S. Bowers ("F") ...	27	338·28	T. Tyrell ("V") ...	22	303·18
R. A. Clifton ("A*") ...	23	296·49	D. Strachan ("C") ...	24	282·09
C. Piggott ("Q*") ...	14	295·97	C. Gilmour ("E") ...	24	276·16
Herd B*	53	293·04	Herd AH	15	267·54
" B	37	292·56	" I	17	257·16
" Q	24	278·55	" 5	17	246·63
" C*	36	273·31	" A	51	235·25
" M*	27	269·99	" K	34	230·17
" R*	23	269·98	" W	17	229·51
" P*	16	267·07	" N	42	229·44
" H	31	262·79	" AC	24	217·84
" E	30	245·04	" V*	29	212·43
" K*	24	235·03	" AE*	39	212·06
" E*	19	234·30	" AD*	43	208·07
" U	29	220·58	" M	24	207·21
" T	26	219·80	" AE	18	204·80
" A	48	218·38	" AJ*	106	182·21
" L*	40	215·05	" AB*	20	146·60
" X	47	211·29	" D*	22	142·56
" T*	21	198·36	" AI	55	141·99
" D*	11	176·12	" AI*	72	134·56
			" AC*	34	131·35

* Letter reversed.

Capel "G."	No. of Cows.	Butter-fat Average.	Balingup "H."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
L. R. Maidment ("W")	10	366·07	S. C. Maidment ("S")	29	313·47
G. Hutton ("N") ...	31	291·17	A. Tomerini ("J") ...	32	308·29
T. Jamieson ("S") ...	29	279·56	M. Brennan ("R") ...	20	295·67
Herd M	36	264·58	Herd N	29	284·24
" C	31	249·60	" A*	31	279·81
" H	44	248·30	" U	36	276·97
" D	38	246·20	" K	43	274·63
" F	41	242·81	" V	35	263·13
" A	81	237·44	" C	39	258·92
" K	32	235·68	" K*	52	257·48
" I	40	233·08	" B*	24	247·32
" P	14	232·24	" D*	16	237·07
" L	79	189·23	" HS	24	236·09
" G	33	187·31	" D	22	234·21
" B	54	177·59	" E	20	233·13
" T	34	168·48	" H4	20	220·10
" E	37	158·10	" P	38	219·37
" O	25	156·55	" H8	25	215·71
			" Q	17	198·14
			" H7	19	194·13
			" E*	14	194·10†
			" G*	51	190·72
			" M	47	146·81

* Letter reversed. † Tested 6 months only.

TABLE 14—*continued.*

Forest Grove "I."	No. of Cows.	Butter-fat Average.	Pemberton "J."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
T. A. Fenning ("N") ...	31	278·965	D. Bendotti ("U") ...	16	277·10
A. & A. E. Millar ("G")	43	277·920	R. R. Graham ("G") ...	16	254·70
E. Hough ("H") ...	18	260·033	D. Della ("N") ...	13	241·15
Herd V	16	252·924	Herd F	18	235·68
" U	20	247·007	" O	21	234·34
" D	40	226·513	" B	18	232·37
" O	23	225·482	" I	20	230·80
" P*	18	220·685	" C	14	222·02
" F*	31	216·916	" Q	20	213·22
" L	14	202·490	" A	16	209·69
" B*	20	198·132	" E	23	206·67
" A	18	194·506	" L	15	206·31
" Z	15	194·348	" T	10	205·33
" S	17	183·746	" H	14	182·46
" C	15	182·758	" W	12	173·60
" Q	24	176·790	" R	25	171·54
" K*	19	176·727	" P	15	171·03
" X	27	173·303	" K	15	164·73
" W	16	168·377	" V	18	149·65
" J	13	165·830	" X	15	107·69
" R*	16	160·341			
" E*	34	158·096			

* Letter reversed.

Rosa Brook "K."	No. of Cows.	Butter fat Average.	Vasse "L."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
G. S. Blaikie ("L") ...	21	310·51	A. M. Patterson ("B")	24	406·32
W. Darnell ("U") ...	19	305·22	L. Johnston ("C") ...	24	311·65
A. Miller ("M") ...	26	292·35	D. H. Bell ("Z") ...	29	284·37
Herd Q	17	278·27	Herd K	16	260·42
" I	19	251·54	" G	22	258·07
" A	30	251·12	" M	20	249·45
" E	13	246·80	" T	40	244·01
" B	32	242·07	" I	33	236·85
" Z	15	240·08	" U	13	223·56
" Y*	20	239·94	" E	26	223·18
" A*	15	233·14	" H	37	221·43
" C	27	232·74	" Y	24	218·59
" X	20	213·26	" D	25	215·44
" T*	15	209·53	" V	11	213·86
" S	18	207·56	" J	20	208·87
" R	13	206·64	" X	20	205·34
" H	28	205·43	" R	14	196·53
" W	19	204·36	" F	20	193·93
" F	24	200·96	" P	12	177·94
" J*	15	194·36	" O	11	172·66
" P	16	193·07	" W	15	167·90
" D	35	182·06	" Q	20	161·64
" J	20	179·51	" A	13	107·31
" Y	18	141·94			
" G	20	130·62			

* Letter reversed.

TABLE 14—*continued.*

Manjimup "M."	No. of Cows.	Butter-fat Average.	Uduc "N."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
Mrs. A. Margereson ("E")	9	283·51	P. MacNeill ("NC") ...	35	264·12
M. Kilrain ("G") ...	25	281·23	A. R. Testar ("CE") ...	25	263·31
W. T. Morgan ("I") ...	10	279·36	E. J. Manning ("EH")	31	255·11
Herd O	18	273·88	Herd NM	21	249·63
" B*	21	267·10	" ND	24	247·85
" B	22	248·61	" NV	17	235·94
" C*	20	237·03	" NU	34	221·33
" R	16	230·49	" NB	19	218·61
" N	13	227·87	" NS	27	215·41
" A	57	220·94	" NJ	18	212·00
" U	20	214·83	" NA	18	193·39
" Q	17	212·38	" NR	33	192·14
" X	30	211·30	" NK	14	189·82
" P	20	195·14	" NL	28	173·33
" E*	26	184·43	" NT	15	166·44
" S	42	182·05	" NF	31	164·15
" D*	19	178·29	" NO	19	163·64
" V	11	174·97			
" T	25	170·95			
" Y	44	161·21			

* Letter reversed.

Benger "O."	No. of Cows.	Butter-fat Average.	Pinjarra "P."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
T. B. Stanley ("M") ...	23	297·99	L. A. House ("L") ...	13	345·63
S. Carlsson ("I") ...	26	294·75	F. G. Williams ("M") ...	27	319·21
W. K. Barnes ("G") ...	28	292·88	Mrs. M. Abbott ("U")	15	275·71
Herd F*	38	284·98	Herd G	26	241·11
" W	29	267·95	" A	31	234·53
" J	44	247·79	" B	31	232·92
" H	20	244·079	" Y	38	226·22
" E	61	243·05	" V	11	223·89
" L	22	235·878	" J	19	216·30
" D	22	234·108	" F	15	208·42
" U	25	230·149	" N	16	196·52
" B	18	215·39	" T	79	192·15
" T	17	213·65	" D	20	189·20
" S	13	190·75	" R	46	189·00
" C	35	179·527	" K	24	187·69
" A	75	176·47	" X	14	186·49
" R	13	166·115	" AB	11	180·87
" K	13	159·72	" Z	27	175·54
			" I	30	165·03
			" C	23	164·63
			" W	18	154·85

* Letter reversed.

TABLE 14—*continued.*

Greenbushes "Q."	No. of Cows.	Butter-fat Average.	Brookhampton "R."	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
F. Heywood ("H") ...	25	306·653	E. J. Kemp ("T") ...	9	267·72
R. C. Williams ("S") ...	43	293·458	F. Leach ("C*") ...	16	250·84
A. Lindsay ("M") ...	30	251·750	C. F. Matthews ("X") ...	19	248·42
Herd W	19	251·208	Herd C	7	244·39
" N	20	247·067	" N	13	239·98
" I	22	245·210	" D*	13	239·55§
" V	29	237·670	" B*	28	239·45
" Y	24	231·105	" E	21	232·77
" B	18	226·51	" S	14	225·14§
" J	20	226·288	" G*	42	210·32‡
" G	21	224·107	" G	38	206·47
" K	23	223·57	" E*	13	205·35
" F	22	218·826	" P	13	202·20
" R	16	218·690	" A*	23	200·90‡
" T*	17	205·250	" Z	15	196·92
" L	19	203·380	" D	16	195·90†
" E	24	199·651	" K	13	195·25
" P	32	192·380	" Y	12	187·55
" T	21	187·298	" F*	72	183·00
" O	20	181·150	" R	10	144·66
" U	40	180·620			
" A	30	173·990			
" D	48	172·550			

* Letter reversed. † Tested 6 months. ‡ Tested 7 months. § Tested 8 months.

Albany "S."	No. of Cows.	Butter-fat Average.	Albany "S"—*contd.*	No. of Cows.	Butter-fat Average.
		lbs.			lbs.
H. L. Newman ("B") ...	19	281·99	Herd V	8	211·23
G. T. Hill ("Z") ...	3	241·99	" E	17	207·21
T. Knapp ("K*") ...	14	239·69	" G	16	194·62
Herd P	11	238·52	" I	35	190·97
" X	17	228·21	" O	18	180·13
" J	9	221·55	" F	13	171 99
" R	12	218·08	" Y	18	155·31
" A	30	217·31	" H	35	153·26
" L	22	215·06	" C*	25	150 26
" D	5	211·97	" T	50	92·98

* Letter reversed.

SHORT TALK ON SEASONAL WORK IN THE ORCHARD.

GEO. W. WICKENS,
Superintendent of Horticulture.

Broadcast Address from Perth National Broadcasting Station, 6WF, on Friday, 6th May, 1938, with notes added on 16th August, 1938.

I have selected "pruning" as the subject for to-night's talk on seasonal work in the orchard, but I want at once to assure listeners that I have no intention of attempting to traverse either in detail, or generally, the many methods adopted in training the various kinds of orchard trees from the time they are planted until they reach the age of profitable production. A written description of the work entailed would fill many pages of a fairly big text book, and would need supplementing with numerous photographs and drawings, for not only is

there a best method of pruning the different kinds of trees, such as stone fruits, pome fruits, citrus fruits, etc., but the methods to be adopted vary for different varieties of the same kind. For instance, what is correct procedure with one variety of apple tree may be quite wrong with another, and the variation goes still further, for what may be correct with a strongly growing tree may be wrong with a tree of the same variety which is only making weakly growth. I have instanced apple trees because I intend to speak about them to-night, but the same statement holds good to a greater or lesser extent with practically all kinds of fruit trees, and I don't wonder the beginner becomes confused when he reads of leaders, sub-leaders, laterals, ramified spurs, fruit buds and leaf buds. I well remember one of these standing in front of a fruit tree with a secateurs in one hand and a text book in the other and saying, "His trouble was that the trees he had to prune did not grow in the same shape as those depicted in the illustrations."

In speaking to-night to commercial apple growers, I hasten to say that I realise there are some of them who know all about pruning. I am aware of this because they have told me so, and to these I am sorry I have nothing to offer, but I also know there are many who, like myself, have had a lifetime's experience of the work and who, in company with me, have to confess they are far from being satisfied that the orthodox method of pruning apple trees, as carried out generally in Western Australia, is yielding maximum good results.

Orthodox methods may be briefly described as follows:—In the first year's winter pruning, assuming the trees are headed and not whips, the shoots are reduced to three or four which are spaced so as to provide the tree with an open centre, and these three or four shoots, which later form permanent main arms or leaders, are shortened back to five or six buds from the fork. The following winter, whether the tree has made strong or weak growth during the intervening spring and summer, the leading growths are again shortened severely; the permanent main arms are increased, if possible, to five or six, and the open centre is still retained. This treatment—hard pruning of leading growths—continues for the first six to seven years of the tree's life, and during that time, if the tree has grown well, it will have produced very little fruit. If the laterals have been stubbed back, as commonly practised with young trees, the yield will have been practically nil, but if these have been left, the lighter growing ones will have produced some fruit in the sixth and seventh years.

The object of pruning the leaders each year hard back to about one third of the length of the annual growth is to produce a sturdy tree that will stand up against wind and rough weather and carry crops of fruit without needing props to prevent the limbs from breaking; and the method outlined does undoubtedly give this result. I think, however, we have been too prone to take for granted that hard cutting is the best way to treat the leaders of a strongly growing apple tree until it settles down to cropping in its seventh or eighth year, and I will mention first a very common fallacy which is held by the majority of pruners, who believe that winter pruning causes a limb at the place where it is cut to grow to greater dimensions than it would have grown had it been left unpruned. That this belief is wrong can be ascertained in one season by cutting some limbs of a strongly growing voung apple tree and allowing others to remain unpruned, and, after the season's growth has finished, measuring the circumference of the pruned limbs at places where the cuts were made, and the unpruned ones at the points where the cuts would have been: in practically every instance the unpruned limbs will be found to be of greater dimensions than the pruned ones. It will be noted I have said the growth will be greater. I have not said the limbs will be stronger for this is not a fact. The unpruned

limbs will be willowy and easily bent, while the pruned limbs will have been stiffened by the joints made as a consequence of the cuts.

During the last few years, however, I have become more and more firmly convinced that we are adhering too rigidly to the orthodox apple tree with leaders stiffened at every 18 inches of their length by severe cutting, and it surely must strike anyone as a wasteful practice to fertilise, cultivate and by clever husbandry induce a tree to make upwards of six feet of growth in one summer season and then, with one violent action in winter, reduce that growth to about 18 inches.

To test my belief that an apple tree with unpruned leaders would, in its early years, make more growth and produce more fruit than an apple tree pruned in the orthodox fashion, I arranged with Mr. George Parke, of Donnybrook, to let me have the training of one of his Granny Smith apple trees from the first season after it was planted as a whip. Mr. Parke is a genuine orchardist, who has an affection for his apple trees, as trees, quite apart from their value as revenue producers, and it was only after some mental strain and severe heart-burnings on his part that he agreed to my request, for to him it was like handing over a well beloved child to a stranger for guidance and training. The tree selected was one of a block of several hundred whips planted in the winter of 1930, and, with the exception of the one cut it received at the time of planting, the leaders have never been shortened since. In the first year three main arms developed about 15in. from the ground; in the second year these increased to six, and in the third to 13, and these 13 form the framework of the tree on which I have trained numerous sub-branches and laterals. At the end of only the first season's growth, the tree's greater height than any other in the plantation was quite noticeable, and the difference became more marked each year until at six years from planting it was feet taller, and the trunk inches greater in circumference than any other tree in the block.

Though the leaders have never been shortened by pruning, I want to stress the fact that the training occupied more time than is taken when pruning a tree in the orthodox manner. In the first place, instead of relying on well-placed cuts to provide the tree with an open centre, this result had to be obtained by tying the limbs to stakes for the first two seasons, and to prevent fruit from setting at the terminals of the leaders I removed the blossoms in the spring of 1931, 32 and 33. The winter pruning also took much longer than the ordinary method for, as orchardists will have noticed, the buds at the terminals of all shoots are much closer together than they are lower down, and this means that an uncut leader will send out from the end anything from three to six growths, and all but the top one was either cut right out or shortened back to a spur. In ordinary pruning this would have been represented merely by one or two cuts. The tree was kept open for light and air by removing small branches from the centre and suitable laterals were chosen and retained for fruit production.

Just in the same way as the tree left all its companions behind in growth, so it did in bearing. In 1934, in its fourth year, it produced one case of fruit: in 1935, 4½ cases; in 1936, 8 cases; in 1937, 8 cases, and this year, 1938, in its eighth year, it produced 10 cases. In the quantity of fruit stated no notice has been taken of windfalls, the cases mentioned being those actually picked and packed from the tree. So from the fourth year to the eighth year inclusive of the tree's life, it provided Mr. Parke with 31½ cases of apples, and I particularly wish to mention here that it carried the crop of 10 cases this year without any supporting props, the only assistance the tree received being that given by a piece of wire encircling the branches so that the stronger limbs helped the weaker ones to stand the strain.

In referring now to the 400 trees in the same block, pruned in the orthodox manner, I want to emphasise the fact that they have received the personal attention of the owner (Mr. George Parke), who is a past-master in the art of pruning. He has given every tree a wide base; has allowed ample room for light and air circulation between the main arms, which he has clothed with well-spaced laterals, but the very vigour of the trees under that system of pruning prevented them from bearing at an early age.

I will relate now the history of the production of the 400 trees pruned in the orthodox manner and the one with unpruned leaders. All trees were planted in 1930. First crop was produced in 1934 and comprised one case on the experimental tree; 1935, total crop 35 cases of which 4½ cases were borne by the experimental tree; 1936, total crop 66 cases, 8 cases on experimental tree: 1937, total crop 199 cases, again 8 cases on experimental tree; 1938, total crop 643 cases, 10 cases on experimental tree.

It will be seen that the total crop produced by 400 trees in eight years from planting amounted to 943 cases, and of these the experimental tree produced 31½. Had the 400 pruned trees cropped like the experimental tree the production in the same time would have been 12,600 cases, or, allowing that the average would be less over the full 400, and taking, say, 25 cases instead of 31½, the production would still have reached the highly satisfactory total of 10,000 cases. And in this year, 1938, had the remaining 400 trees produced equally with the experimental tree instead of 643 cases, Mr. Parke would have had 4,000 cases for sale.

I know to many growers these figures will sound fantastic. Certainly they are sufficiently arresting to cause one to think seriously, and my advice to doubting orchardists is to choose a piece of really good land, plant out 100 Granny Smith apple trees, scatter a few Jonathans and Yates amongst them for cross pollination purposes, make the trees grow strongly, treat the Granny Smiths as I have suggested and bank the profits. Charles Dickens makes one of his characters say, "Train up a tree in the way it should grow, and when it grows big sit under the shade of it." Well, if shade is the main consideration, prune hard and vigorously; if fruit is desired early in the tree's life, try the unpruned leader system.

To those who think hard winter pruning makes a tree grow, I would point out that the experimental tree now measures 16ft. 6in. in height and 15ft. in width through the branches, and the biggest pruned tree in the block is only 11ft. in height and 8ft. 6in. in width. Not only is it the tree with the greatest dimensions and capacity for bearing fruit, but I am convinced it has a stronger constitution than any of the pruned trees due to the fact that the sap flows in a comparatively straight line from the roots to the tops of all main limbs. And though I have no proof I am quite prepared to believe that hard pruning is one of the contributory causes of "Die-back," which so often puzzles us by appearing in what are otherwise apparently healthy trees.

My time is nearly up, and now that I am well astride of my hobby horse I regret exceedingly that I cannot continue riding it for a longer period, for there are pitfalls in the system advocated. The grower who thinks that I am handing out advice that if followed will lessen the time he now occupies in winter pruning has a heap of other thoughts coming to him, and I would strongly advise those interested to communicate with me at the Department of Agriculture, when I shall be only too delighted to discuss the matter with them. If any keen orchardist amongst my listeners takes my advice about trying a small experiment with 100 trees I can assure him he will find it more entertaining than the pictures, and more profitable than going to the races; but remember, the system advocated is not suited to weakly growing trees.

NOTES ADDED ON 16th AUGUST, 1938.

Since the above broadcast was delivered on the 6th May, I have given demonstrations and talks on the subject in most of the principal apple growing districts in the State, and as a result there are now some hundreds of trees that have been treated this pruning season in the manner advocated. To those who were not present at the demonstrations, and who may decide to give the new method a trial, I wish to sound a word of advice regarding supporting, by staking, the unpruned limbs in the first and second season. The stakes are merely pieces of sawn timber 6ft. x 1in. x 1in., or their equivalent in props cut direct from the forest. The ends should be driven into the soil close to the butts of the trees so as not to be in the way of implements, and then the stakes should slope outward one to each limb at an angle that will bring the tops of the year's growths to approximately where they would have reached had the tree been pruned in the ordinary manner.

The necessity for staking only arises when upright growers, such as Granny Smiths and Cleopatras, are being treated. These, if left unpruned and unstaked, will grow with centres so close and dense as to interfere with cropping; but care must be taken not to prop the trees out too widely, nor bend the young growths abruptly outwards, for this will cause the over-bent limbs to put out strong growths on the insides, or rather upper sides, of the limbs and check the terminal growths.

Three photographs of the experimental tree are shown hereunder:—No. 1 was taken in November, 1934, when the tree was in its fourth year, and shows the size in comparison with the trees pruned in the orthodox manner; the lack of leaves on all trees was due to the photograph being taken in early November before the trees were fully foliaged. No. 2 is a photograph taken on the 20th July of this year, and shows that the tree, in spite of having borne heavy crops in the last three years, and with very little propping, has retained its shape and the limbs have neither been unduly bent nor broken.

It also shows the method by which the tree has been furnished with bearing wood from bottom to top by using lateral growths for the purpose and avoiding short spurs. I stated in the broadcast that if laterals have been stubbed short, trees when six to seven years of age will have produced practically no fruit and this is true of strongly grown trees, whether leaders have been pruned or left unpruned. It is a fact that many apple growers still continue the practice of spurring nearly all laterals at time of winter pruning (and some do it both in Winter and Summer) with the object of causing the fruit to be borne on short growths and ramified spurs situated close to the main leaders, and under this treatment an apple tree will produce very little fruit until it is upwards of eight years of age. Whereas if full use is made of the laterals by leaving unpruned the light and medium sized ones—which grow horizontally or nearly so from the leaders—fruit buds will be furnished in the second year of the laterals' growth. Growths which are too strong and upright to leave for laterals can be pruned in winter to buds on the under sides, until their vigour is checked and their direction is less upright and then left unpruned to furnish fruit buds. When the fruit buds are formed it is a simple matter to prevent over cropping by shortening the laterals as required.

It is, I think, universally known that the best Jonathans for size, colour and quality, are produced on laterals, but it is not so generally recognised that this is equally true of Yates, Dougherty, Granny Smith and many others.

Photo. No. 3 was taken at the same time as Photo. No. 2 and is reproduced to show the full size of the tree at eight years old.

In conclusion, I wish to emphasise the fact that except for the difference in the methods of pruning, the experimental tree received exactly the same treatment as the remainder of the plantation, cultivation and manuring being uniform throughout.

WITHER TIP OR SUMMER DIEBACK.

T. C. DUNNE, Agricultural Adviser.

There has apparently been a tendency in some quarters to confuse "Wither Tip" disease of apple trees with the more general type of dieback termed "Pruning Dieback." To date there is no evidence that any connection exists between the two diseases, or that copper applications which have proved effective in controlling "Wither Tip" are of any use in the treatment of the other disease.

A discussion of "Wither Tip" was published in the Journal of the Department of Agriculture in March, 1938. This trouble is characterised by the withering back in December or January of shoots which made growth during the spring and early summer. On the other hand with "Pruning Dieback" it is noticed that the leaders fail to develop vigorous spring growth at all, the leaves being often very small and giving a rosetted appearance to the shoots.

With a view to controlling the "Wither Tip" disease soil applications of copper sulphate may be made during August or September. Copper sulphate fines applied at the rate of 1 lb. per tree for young trees and 2 lbs. per tree for trees of bearing age has proved satisfactory. The material should be spread in a ring over an area extending about three to six feet from the tree and dug in thoroughly. In the case of older trees it may be necessary to follow with a summer strength Bordeaux spray (3.3.40) towards the end of November in order to present any recurrence of the disease. After the first season's treatment it should be possible to discontinue the spraying.

VARIETIES OF PEDIGREE SEED AVAILABLE FOR DISTRIBUTION.

I. THOMAS, Superintendent of Wheat Farming.

As in past years the Department is again this year making available supplies of pedigree seed, produced at the Agricultural Research Stations for distribution to farmers. It is not suggested that a farmer should obtain all of his seed wheat requirements from the Department, but rather that he should obtain a few bags of pedigree seed and sow this in a plot and then use the grain obtained from this plot for his seed requirements the following year.

The aim of the Department is to supply as many farmers as possible with pedigree seed and thus owing to the fact that some of the varieties may be over applied for, it may be necessary to limit the amount of each variety supplied to any one applicant in order that this object may be obtained.

It is anticipated that this year the following varieties will be available for distribution:—

WHEAT.

Baroota Wonder.—A late maturing variety, resistant to flagsmut, but is liable to rust. This variety is recommended for hay in the better rainfall districts.

Bencubbin.—A midseason maturing variety, resistant to flagsmut, but is very liable to rust and is not recommended for those districts where rust is feared.

Carrabin.—An early maturing variety of high quality grain; resistant to flagsmut and rust escaping.

Comeback.—An early-midseason maturing variety of premium milling quality. It is resistant to flagsmut and rust escaping.

Ford.—A midseason maturing variety resistant to flagsmut and rust.

Geeralying.—A very early maturing variety, resistant to flagsmut and rust escaping. It is liable to shed.

Gluyas Early.—An early maturing variety; resistant to rust but liable to flagsmut.

Merredin.—An early maturing variety, susceptible to flagsmut, but rust escaping.

Nabawa.—A midseason maturing variety, resistant to flagsmut and rust. Recommended for those areas where rust is feared.

Noongaar.—A very early maturing variety which is drought resistant, being most suitable for areas having a short growing period and for very late planting in those districts having a better rainfall; resistant to flagsmut and rust escaping.

S.H.J.—An early maturing variety producing a grain of high milling quality. It is resistant to flagsmut and rust.

Sutton.—A late maturing variety, resistant to flagsmut and moderately resistant to rust. This variety is not recommended for areas of low rainfall.

Totadgin.—An early maturing variety; resistant to flagsmut.

OATS.

Algerian.—A late maturing variety. Owing to slow early growth it is not recommended for early green feed.

Burts Early.—An early maturing variety which is especially suitable for hay, silage and early green feed.

Guyra.—A midseason maturing variety mostly favoured for its grain which is large and plump.

Mulga.—An early maturing variety suitable for hay, grain, silage and early green feed; superior to Burt's Early for grain.

Wongan.—A very early maturing variety which was produced at the Wongan Hills Research Station from a cross between Mulga and Burts Early. It has short, strong straw and is suitable for early green feed and grain in the drier areas or for late planting in the wetter districts.

BARLEY.

Atlas.—A six-rowed barley which has been introduced from California; it is also known in this State as Californian Six-Row Barley. In England it is used for malting purposes, but it is not employed for this purpose by local brewers whose technique is based on the use of two-row barleys such as Pryor. It is grown mainly for green feed and is quite equal in this respect to Cape, Bald Skinless or Black Barley, while for grain its yield is superior to Cape.

Applications for pedigree seed should be made *direct* to the Department of Agriculture, Perth.

The seed may be obtained under the Exchange System, which has operated for the past few years, when the farmer has been able to exchange his own f.a.q. wheat for pedigree seed on the following basis:—

4½ bushels f.a.q. wheat for 3 bushels pedigree seed wheat or barley.

3 bushels f.a.q. wheat for 3 bushels pedigree seed oats.

Where the applicant prefers to pay cash for his seed the following prices are charged:—

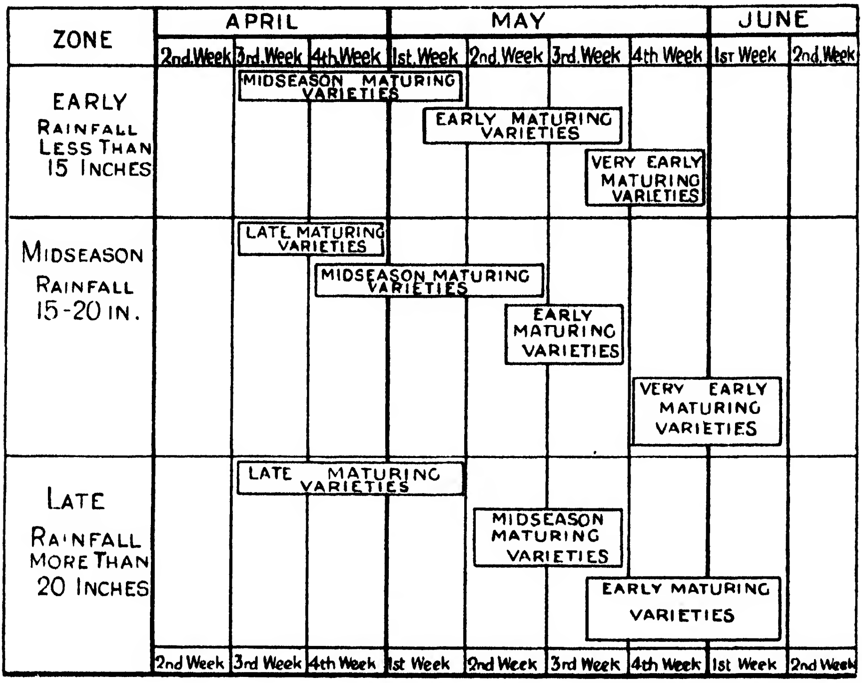
Wheat and barley, 18s. per bag of 3 bushels.

Oats, 12s. per bag of 3 bushels.

Both of these transactions are inclusive of rail freight on the seed to the settler's siding.

Applicants are advised to make early application for their requirements, setting out clearly their name and postal address, together with the siding to which the seed is to be railed.

SEEDING CALENDAR WITH RECOMMENDED VARIETIES FOR THE WESTERN AUSTRALIAN WHEAT BELT.



RECOMMENDED VARIETIES.

Late Maturing.	Midseason Maturing.	Early Maturing.	Very Early Maturing.
Wheat— Sutton, Yandilla King, Baroota Wonder (for Hay)	Bencubbin, Ford, Nabawa	Gluyas Early, Merredin, Totadgin Premium Varieties—Carrabin, Comeback, Pusa IV., S.H.J.	Geeralying, Noongaar.
Oats— Algerian	Guyra	Burt's Early, Mulga	Wongan.

When planting for hay, sow 7–10 days earlier than for grain.

WESTERN AUSTRALIA—DEPARTMENT OF AGRICULTURE.

LIST OF BULLETINS AVAILABLE FOR DISTRIBUTION.

No. 20.—*The Pruning of Fruit Trees.* J. F. Moody. Price 2s. 6d.
No. 38.—*Linseed or Flax and Its Cultivation.* Geo. L. Sutton.
No. 46.—*Fruit Packing and Marketing and Exporting of Fruit.* J. F. Moody and J. Ramage. Price 1s. 6d.
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No. 60.—*The Farmer's Clip.* J. J. Mahood.
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No. 122.—*Codlin Moth : Descriptive Account together with Notes on its Control.* L. J. Newman.
No. 126.—*The Rusts of Cereals.* H. A. Pittman.
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PRODUCER GAS EQUIPMENT ON TRACTORS IN WESTERN AUSTRALIA.

R. P. ROBERTS.

(At present on loan from the State Department of Agriculture to the Institute of Agriculture in the University of Western Australia for agricultural economics research.)

INTRODUCTION.

When wood or charcoal is burnt in the presence of only a limited supply of air it gives rise to a mixture of gases known collectively as producer gas, suction gas, wood gas, charcoal gas, etc. This mixture of gases consists principally of carbon monoxide and hydrogen, which are inflammable, and the non-inflammable gases carbon dioxide and nitrogen. If water vapour is introduced into the generator the proportion of hydrogen in the mixture is increased.

The use of this gas mixture in internal combustion engines has been practised for many years, but has been confined chiefly to the stationary engine, where the weight and size of the necessary generator and cleaners are unimportant. Its successful utilisation as a fuel for motor-powered vehicles presents difficulties, but from time to time efforts have been made to adapt it to them.

Countries most interested, for both economic and political reasons, in the utilisation of producer gas as a source of power are those dependent on foreign supplies of oil. If producer gas could be used for motor vehicles it would be cheaper than using imported petrol and, in addition, would greatly decrease the vulnerability of the country in time of war. European governments in particular have been interested in the latter aspect of the situation and have been experimenting for years in endeavours to overcome the problems connected with the substitution of wood or charcoal gas for petrol.

The use of producer gas in agricultural tractors has also received attention in Europe and the "International Review of Agriculture" for 1927-1930 contains several references to charcoal burners and gas generating plants. In England in 1928 the "Implement and Machinery Review" made favourable comment on a Parker Bros. gas plant attached to a Fordson tractor. The design of this plant appears very similar to those which have been developed in this State.

Many of the difficulties associated with the use of gas could be surmounted in an engine specifically designed to burn this type of fuel. It is thought likely that tractor engines of this type are in existence in Russia, while the "Interna-

tional Review of Agriculture" for April, 1938, briefly reviews some work at Stuttgart, Germany, connected with the designing of a small tractor engine to burn wood gas.

However, the problems of immediate concern are connected with the conversion of kerosene tractor engines to operate on gas.

The essential features of the majority of plants operating in Western Australia are—

(1) a metal container of cylindrical shape containing 80-100 lbs. of charcoal;

(2) a small water tank and drip tap; and

(3) a series of cleaners or scrubbers in which the gas is cleaned and cooled before it enters the engine.

The gas is formed by passing air and steam through a very hot fire maintained at the bottom of the charcoal in the container.

HISTORICAL.

In Western Australia the first stimulus to the farmers' interest in producer gas as a substitute for kerosene in tractors came through the collapse of wheat prices in 1930. Every possible way of reducing costs had to be considered. In the case of the owners of kerosene tractors one of the heaviest items of expenditure in the yearly budget was fuel. Australia has only negligible oil resources and practically all supplies have to be imported. On the other hand there are large quantities of wood suitable for conversion into charcoal, particularly in Western Australia. Any method, therefore, which would enable tractor operators to substitute charcoal, often burnt from waste timber on their own farms, for costly imported fuel was worth a trial even though the working efficiency of the tractors might be reduced.

The first producer gas unit on a tractor in Western Australia was used at Xantippe about 1931. It was a plant of English manufacture but does not appear to have been particularly successful. It was seen by Mr. P. Salvaire of Manmanning who had previously operated a stationary producer gas engine at Northam. Mr. Salvaire shortly afterwards constructed and fitted producer gas plants to a Rumely tractor, a Fiat tractor and a Vulcan truck. All these machines and gas plants are still in working order though the gas equipment is not now in constant use. The plant fitted to the Rumely appears to have been the first one constructed in Western Australia.

Others followed this example and for a time there was considerable interest displayed in producer gas. Many plants were failures from the start. Others depreciated rapidly owing to faulty construction. On the other hand some farmers showed extraordinary ingenuity in building and successfully operating gas plants on their tractors for a number of years. With the recovery of wheat prices interest in gas began to wane, but some of those who reverted to kerosene fuel tractors were ready to admit that the change over to producer gas for two or three years during the worst of the depression had enabled them to stay on their farms.

Several firms and individuals were for a time interested in the manufacture and sale of gas units, but none of them was in a position to spend the necessary time and money in research and experimentation before putting their machines on the market. In consequence there were often some very dissatisfied purchasers who, after a short trial, resolved they would not again have anything to do with producer gas.

Towards the latter end of 1937 there was a revival of interest in producer gas. The possibilities of war and the curtailment of oil supplies had turned public attention to its potentialities as a substitute for petrol and kerosene. There were indications of another period of low wheat prices, which meant that farmers would

again be seeking for means whereby their cash outlay could be reduced. As a result of the practical experience gained in the past the gas plants then being marketed were decidedly in advance of those obtainable four years previously, and the advent of a new company to manufacture a plant designed as the result of some years' experimentation, gave grounds for hope that further improvements would be forthcoming.

In 1937 money for research work became available from the Commonwealth grant to Universities and an allocation was made to the Engineering School in the University of W.A. for carrying out investigations into the mechanical problems involved in the use of producer gas for tractors, etc.

In 1938 money from the same source supplemented by a grant from the Trustees of the Wheat Pool of Western Australia enabled studies in agricultural economics to be initiated in the Institute of Agriculture in the University of W.A. The first subject selected for investigation was that of tractor operations in the wheatbelt, and in order to supplement the work of the Engineering School it was decided that special attention should be given to producer gas. The first step in this connection was to obtain an accurate picture of farmers' experiences with gas. Questionnaires were therefore sent to as many people as could be located who had used gas plants on tractors. This paper is based largely on the replies received to 67 of these questionnaires supplemented by personal visits to a number of operators. It sets out the chief problems which have been encountered in the past and gives some indication of the degree to which they have been overcome.

Statistical information supplied by one of the oil companies disclosed that at the end of 1937 the 1,548 tractors in Western Astralia could be classified into the following types:—

Spark tractors burning kerosene	3,924
Diesel and semi-diesel or hot bulb tractors	562
Spark tractors burning producer gas	62

Since that date the number of producer gas tractors has risen to over 200.

MAKES OF GAS PLANT.

The different makes of plant used on the 71 tractors for which information was obtained by questionnaire have been allotted distinguishing letters. The numbers of each type, together with information concerning the numbers which had been discarded prior to filling in the questionnaire, are shown in Table I.

TABLE I.

Make of Gas Plant.	Number included in Survey.		
	In Use.	Discarded.	Total.
A	...	2	2
B	3	5	8
C	19	8	27
D	1	4	5
E	27	1	28
F	...	1	1
Total	50	21	71

Types A, B and F represent makes which are not now sold. Home constructed plants have been designated type D. Types C and E are both obtainable at present

but C has been on the market for considerably longer than E and consequently is represented by a greater proportion of older plants.

At the recent Royal Agricultural Show at Claremont four types of producer gas plants were included in the trade exhibits. These were types C and E, and two makes not previously on the market.

MAKES AND H.P. OF TRACTORS.

In Table II. are given data concerning the makes and rated draw bar horse power of the tractors included in the survey. The figures in brackets indicate the number in each class which were fitted with pneumatic tyres.

TABLE II.

Make of Tractor	Rated Draw Bar Horse Power.											
	12.	15.	17.	18.	20.	22.	23.	25.	26.	27.	30.	Total.
Case	2 (2)	3		27 (15)		1 (1)		1	1 (1)		5 (4)	40 (23)
McCormick-Deering		11 (3)										11 (3)
John Deere		5 (3)										5 (3)
Twin City			3 (2)							1 (1)		4 (3)
Hart Parr				2 (1)								2 (1)
Caterpillar		2				1						3
Wallis					2 (1)							2 (1)
Massey-Harris									1 (1)			1 (1)
Vickers							1					1
Ronaldson Tippet						1						1
Rumeley		1										1
Total	2 (2)	22 (6)	3 (2)	29 (16)	2 (1)	3 (1)	1	1	2 (2)	1 (1)	5 (4)	71 (35)

Forty-nine per cent. of the tractors operated on pneumatic tyres and 4 per cent. were of the crawler type. The horse powers given are the rated figures for horse-power available at the draw bar when the tractor is working on kerosene and is not fitted with pneumatic tyres. When converted to producer gas it can be assumed that the tractors in the survey would be capable of developing, on an average, from 70%-80% of these figures. In the case of those tractors fitted with pneumatic tyres, however, the figures given would approximately represent the power available when on gas.

The widespread adoption of pneumatic tyres for farm tractors in Western Australia during the past two years, has considerably enhanced the possibilities for the successful utilisation of producer gas. Vibration on the tractor is considerably reduced—an important point when a gas plant is attached—and the extra power available at the draw bar will usually more than counterbalance any loss due to converting the tractor to gas.

AGE OF TRACTORS.

Information was obtained concerning the ages of some of the tractors when gas plants were fitted and is given in Table III.

TABLE III.

	Age of Tractor when Plant Fitted (Years).										
	When Purchased or less than 1 Year	2	3	4	5	6	7	8	9	10	Over 10	Total.
No. of Tractors	**13**	**3**	**1**	**1**	**6**	**2**	**5**	**3**	**3**	**5**	**2**	**44**

From this it will be seen that there were probably instances in which gas plants were fitted on tractors which were already worn out and would perform inefficiently even on kerosene.

Of the forty-five operators who were still using gas at the time of the survey one had worked his plant for six years, five for five years, three for four years and seven for three years. Twenty-one plants had been in use for less than one season.

Twenty reports were received from tractor owners who had discontinued the use of gas. One had worked his plant for four years, three had used theirs for three years and five for two years. Seven had used them for less than a season, one man returning his to the agent after three weeks' work.

The information given in the preceding tables indicates the variety of conditions under which endeavours were made to substitute gas for kerosene, and it is hardly surprising to find that a number of those who tried it were disappointed with the results.

Of the twenty who reported they had discontinued using their gas plants, two were satisfied with them but one had given up farming and the other was away from his place most of the time and could not get a reliable man to work his plant. Reasons advanced by the others for discarding their plants were loss of power and consequent delay in getting through the work, too much time taken in looking after the plant, ignition troubles, valve trouble, rusting away of shell of plant, dirtiness of operation, excessive engine wear, difficulty in obtaining good charcoal. In view of the importance of these points they will be briefly examined in the light of the knowledge gained from numerous sources during the course of this survey. Most of them are at present being investigated in the Engineering School, which will publish reports in due course. In the meantime the following general remarks will not be out of place.

LOSS OF POWER.

Due to the difference in calorific value it is not possible to obtain as much work from a given volume of producer gas at a given temperature as from the same volume of kerosene vapour at the same temperature. However, it is possible to make certain modifications to the engine which will enable some of this loss of power to be regained.

As a result of the necessity for adequate vaporisation, the mixture of kerosene and air is drawn into the cylinder at a high temperature. As there is not the necessity for these high temperatures with gas, it can be taken into the engine at a much lower temperature than can kerosene and consequently a greater weight of gas can occupy the same cylinder space. The replacement of the kerosene manifold by a cold manifold is usual when converting to gas. This enables a small increase in power to be effected.

Kerosene tractors are usually built with a compression ratio of about 4.5 : 1. Increased compression will give greater power, but with kerosene there is the difficulty of pre-ignition if the compression be appreciably increased. As this difficulty does not occur with producer gas it is possible to obtain an increase in power by increasing the compression ratio, but as the tractor has to be started on petrol this cannot be done beyond a point where high grade spirit can be used without the risk of detonation. In a large number of cases the ratio adopted for gas is about 7 :1.

Most of the tractors included in the survey had compressions increased to some extent, though there were exceptions. In some cases compression was increased merely by bolting plates on the top of the old pistons. However, this is not a method that can be recommended; proper high compression pistons or a high compression head should be fitted, otherwise trouble is likely to follow.

There are some makes of tractors in which it is possible to bore out the cylinders and fit oversize sleeves, thus giving an increased bore and consequent increased power. Only one or two of the tractors included in the survey were treated

in this manner, but it is understood that several of the tractors recently fitted with plants have had these alterations made, and as high compression pistons are fitted at the same time their power output should be brought back nearly in line with what it was when using kerosene.

When buying a tractor difficulties connected with possible loss of power can be avoided by obtaining one of greater rated horse power than would be necessary if it were to operate on kerosene. This entails a fairly appreciable increase in capital outlay which tends to offset the advantage of cheap fuel costs possessed by the gas driven machine.

With the use of gas and high compression ratios, best results are obtained by advancing the spark. However, the higher compressions bring increased liability to ignition trouble, a fact which was made very clear by the survey.

IGNITION.

Nearly 50 per cent. of the operators who answered the questionnaires had experienced and recognised ignition troubles of some kind. In most instances these can be attributed to the use of gas, or perhaps more properly to the engine modifications made when gas was adopted. With high compression ratios greater demands are made on the electrical system. The magneto has to be maintained in first-class order, otherwise a change to battery ignition is advisable. Many operators found it necessary to decrease the gap between the points of the spark plugs and adjust them more frequently. A cooler burning type of plug than is used with kerosene is advisable, but the most suitable types for different tractors do not yet appear to have been established.

Although troublesome, the importance of ignition breakdowns encountered when using gas should not be over-estimated. As several operators have found for themselves a change to battery ignition will usually overcome most of them; in fact, one man stated that after fitting battery ignition all his troubles with the gas plant disappeared completely. However, battery ignition adds to the capital outlay involved when converting to gas.

VALVES.

Valve trouble had been experienced to varying degrees by 50 per cent. of the operators who replied to the questionnaire. It usually took the form of tarry materials being deposited on the valve stems and preventing them from working freely in the guides. In several instances the operator had discovered for himself that the real cause of the trouble lay with incompletely burnt charcoal giving rise to volatile substances, which passed through the cleaners and deposited in the engine. By making certain that only well prepared charcoal was used a lot of this trouble was overcome. Further assistance in avoiding sticking valves has sometimes been afforded by the fitting of a drip feed to the valve stems. This enables the valve stems to be lubricated by oil or, better still, a mixture of oil and kerosene.

A few cases were investigated in which excessive deposits were being formed in the cylinders or on the valves, where the cause could not be ascribed to badly burnt charcoal and where the deposits were not of a tarry nature. The information given by those who had experienced the trouble, suggested that a mineral salt was being deposited in the engine. In only one instance was it possible to obtain a sample of these engine deposits. This was taken from a tractor which for several months had been working satisfactorily on producer gas. Charcoal was then used which had been burnt from timber obtained from a different locality to that from which previous supplies had been drawn. Trouble was shortly afterwards experienced and when the cylinder head was removed heavy deposits of a brown material were found.

Mr. R. Harvey, of the University Institute of Agriculture, kindly volunteered to analyse the deposits. The details of this analysis are given in Appendix No. 1.

The analysis suggests that among other things, salt was finding its way through to the engine, and as the only possible form in which this could carry over from the generator would be in the form of a fine dust, it appears as though the gas cleaners were not entirely efficient.

At the time when the above analysis was made, an examination was also made of a white crumbly deposit taken from the wall of the same producer gas generator immediately above the fire zone. As this was largely composed of calcium oxide it seems likely that there was an appreciable amount of combined calcium in the charcoal and in the wood from which the charcoal was prepared, and that this volatilised in the producer and in cooling was deposited in the walls. However, the information so far obtained on this point is only sufficient to suggest possibilities for further investigations.

CLEANERS.

The weakest feature of the producer gas plants fitted to the tractors investigated in this survey appears to be the cleaners for the gas.

Only 50% of the operators gave an unqualified "yes" in reply to the question. "Are the cleaners satisfactory?"

There are some tractors on which the cleaners are achieving their object, but, on the other hand, it is evident that what suits one type of tractor is not necessarily suitable for another make and that the efficient working of the scrubbers is affected by such factors as speed, load, etc.

The usual procedure is to have the gas pass through two dry cleaners, where by means of a series of baffles, or by imparting revolving motion to the gas so that heavy particles are thrown to the outside, the larger particles are removed. The partially cleaned gas is then drawn through an oil cleaner with the object of ridding it of the finer dust particles.

The effectiveness of these arrangements varies considerably. In some cases appreciable amounts of the oil used in the cleaners are actually consumed in the engine, either through being sucked in in liquid form or by being vaporised and carried in with inadequately cooled gas. Both these conditions are undesirable, for if oil is being carried in in its liquid form it will carry over some of the dust and grit extracted from the gas; on the other hand if it is vaporising then the gas is entering the engine at too high a temperature.

CHARCOAL.

Good charcoal is essential for the efficient operation of a producer gas plant, but from the information collected during the survey it appears that the quality of some of the charcoal used often leaves much to be desired. Charcoal burners operate in the Darling Ranges some 30 miles east of Perth, and charcoal is obtainable from them at about £2 5s. per ton. If bought in minimum lots of 7 tons (a small truck load) freights are not excessive as will be seen from Appendix II., but if smaller quantities are purchased a much higher rate has to be paid. Despite the fact that most farmers are able to land charcoal on their farm at somewhere near £3 per ton, it was found that 75 per cent. of those included in the summary elected to burn their own requirements.

In indicating their choice of woods for preparing charcoal there was a decided preference shown for wheat belt timbers and wandoo or white gum, as against the jarrah which forms the bulk of the charcoal burnt in the hills. With most farmers who had used them, charcoal from white gum or mallee roots was preferred. These timbers appear to give a denser coal which does not burn as hot as jarrah, and which will keep alight better and give more power per unit of weight.

Trouble has also been experienced with bought jarrah charcoal on account of it containing ironstone gravel, which causes excessive clinker formation in the grate of the producer and frequent stops for cleaning out. As it is very difficult on most of the plants at present in use to remove the grate without allowing time for it to cool after the fire has gone out, this causes a serious loss of time. Careful screening of charcoal will eliminate much of the trouble of this type.

It will be seen that there is scope for a considerable amount of investigational work into the relative values of the different woods for charcoal production, and also on the effect of environment, *e.g.*, proximity to salt lakes, on the suitability of timbers for charcoal.

FUEL CONSUMPTION.

The producer gas tractor utilises charcoal and water as fuel, and, in addition, requires a small quantity of petrol for starting. Information was sought in the questionnaire concerning the quantities used when working for ten hours under full load. In the case of the 18-32 h.p. type tractors, which accounted for 56 per cent. of those covered in the survey, fourteen which were fitted with the same make of gas plant consumed on an average 246 lbs. of charcoal, 3.3 pints of petrol and 4.6 gallons of water per day.

It would be reasonable to expect that these tractors would be capable of developing on gas at least 70 per cent. of their rated kerosene horse power of 32, *i.e.*, 22.5 horse power. Tests at the Engineering School suggest it is rather unlikely that, under average conditions, it would be possible to obtain a lower charcoal consumption than 1.5 lbs. per brake horse power hour. On a basis of 1.5 lbs. per brake horse power hour, therefore, if developing 22.5 horse power, these tractors should have consumed 337 lbs. of charcoal per day. Even with the 1.25 lbs. which might be obtained under very favourable conditions the consumption would be 280 lbs.

The amount of water consumed is also too low, as a normal figure would be 0.37 lbs. per brake horse power hour giving a daily consumption of about 8 gallons per tractor.

Similar figures were calculated for all the tractors in the survey. The average rated brake horse power was 34 and the tractors on gas should, therefore, have been capable of developing 24 horse power, and for ten hours' work under full load they should have consumed some 360 lbs. of charcoal and 9 gallons of water. The actual figures, however, were 248 lbs. of charcoal $3\frac{1}{2}$ pints of petrol and $5\frac{1}{2}$ gallons of water.

Some of the operators who appeared to be using unduly small quantities of charcoal were asked to confirm the figures given, but as a result nothing more than minor alterations were made. There was no correlation between operators reporting unusually high loss of power as compared with kerosene and those giving low figures for charcoal consumption. It would be unwise to attach too much importance to these figures as they are possibly due to the fact that many of the tractors could not have been working at full capacity for the whole of the ten working hours. However, further information upon this rather interesting point will possibly be available when the field tests, at present being conducted by officers of the Engineering School with producer gas powered tractors, are completed.

In addition to charcoal, water and petrol, the producer gas tractor uses grease and engine oil as do kerosene tractors, and also in most cases a certain amount of crude oil or sump oil in the final gas scrubber. The oil in this gas cleaner has to be changed from time to time but, in addition, a small quantity usually disappears each day by being drawn through into the engine and burnt. Normally this should not exceed about one pint per day, but a few cases were encountered where something was at fault and the engine was drawing through and burning a considerable quantity. Needless to say a situation in which crude oil contaminated by dirt and

grit is burnt in an engine designed for kerosene is bound to lead to serious trouble.

Estimates of the yearly saving effected in fuel and oil by using producer gas instead of kerosene, were asked for. These of course varied according to the acreage covered, size of tractor, hours used, etc. The answers also varied considerably and were not all on a comparable basis, but the general impression gained was that savings in fuel would amount to 70-80 per cent. of the expenditure on kerosene and that the bill for lubricating oil would be reduced by from 50-75 per cent.

REPAIRS AND DEPRECIATION ON TRACTOR.

If the repairs and depreciation on the tractor itself are increased as a result of fitting a gas generator, then some or all of the advantages gained by the use of the cheaper fuel will be lost. Operators were, therefore, asked whether in their opinion (a) depreciation had been increased or decreased and (b) whether expenditure for overhauls and repairs had been increased or decreased as a result of the conversion. The replies to these questions are summarised in Table IV. The figures in brackets refer to the 14 tractors of 32 horse power fitted with a late model gas plant.

TABLE IV.

Expenditure.	Depreciation on Tractor.	Overhauls and Repairs.
Increase	12 (1)	15 (2)
Decreased	31 (7)	14 (4)
Unaltered	14 (3)	18 (3)
Indefinite or no reply	10 (3)	20 (5)
Total	67 (14)	67 (14)

Provided that the necessary alterations to the tractor have been correctly made, that properly burnt charcoal is used, and that clean gas is supplied to the engine, costs under the headings of depreciation and overhauls and repairs for the tractor itself should be certainly not greater than with kerosene. That these conditions are not always realised in practice is obvious from the table. Excessive depreciation can be caused by unsatisfactory cleaning of the gas, while increased overhauls may be rendered necessary by the same cause or by the use of imperfectly burnt charcoal causing tarring of the valves or ignition troubles. However a number of the operators undoubtedly were obtaining good results and in reply to the question, "What stoppages or breakdowns have you had which you could attribute to the use of gas?" 21 of the 59 who replied said "none," seven of these were in the group of 14 already referred to. In a number of other cases the breakdowns were of only minor importance.

DAILY ATTENTION.

The producer gas powered tractor is at some disadvantage as compared with the kerosene tractor in respect to daily labour requirements. Each morning the residual charcoal and ash has to be taken from the generator. With the majority of plants a fairly heavy iron grate has to be removed and the clinker cleaned off it. The generator then has to be refilled with charcoal, a fire lit and the engine started and run on petrol for a short period in order to get the fire drawing well. It is usually necessary to stop and refill the generator with charcoal in the middle of the morning, at lunch time and again in the afternoon.

A certain amount of attention to the cleaners is also necessary. In order to obtain some idea of the time necessary for these operations those to whom question-

naires were sent were asked for an estimate of the extra cost involved on a basis of 1s. per hour for labour. These replies ranged from nothing to 2s. 6d. per day. Even if the latter figure be taken it does not suggest that the extra amount of daily service required is likely to be a factor limiting the use of gas plants.

GENERAL.

There are a number of other points raised by operators, some of which can be classed as minor disabilities associated with the use of producer gas.

The gas plants fitted on many of the tractors have generators the tops of which are as much as 7 ft. from the ground, and reaching up to empty a 50-60 lb. sack of charcoal into one of these when it is hot, is a job not unattended by an element of risk. Also handling charcoal is a dirtier job than handling kerosene, and a mixture of oil and charcoal dust is particularly unpleasant. Each stop for refuelling means that the fire dies down and it is not always possible to start the tractor again directly on gas.

The extra controls and the necessity of having to regulate by hand the quantity of water entering the producer, are disadvantages which make the tractor somewhat more complicated to operate than is the kerosene machine.

The plants are usually heavy, bulky and unsightly. As fitted to some tractors they obstruct the view of the driver and a few complaints were heard of faulty construction and attachment to the tractor. In one or two instances operators complained of discomfort in hot weather due to the close proximity of the gas generators.

Danger of fire when harvesting does not appear to be serious provided reasonable precautions are taken, mainly when re-fuelling.

Suggestions made by operators for improvement of gas plants included more efficient gas cleaners, use of drop grate instead of the screw on type, better cooling of the gas, check valve to prevent back pressure of engine to generator, utilisation of wood instead of charcoal, instalment of a super-charger, arrangement for grate removal without interfering with fire, an engine designed specifically for gas, lighter and more compact plant, lower initial costs (at present it costs about £85 to convert to gas) and automatic water feed.

The final point dealt with in the survey was the attitude of operators towards producer gass. Did falling prices force them to turn to a cheaper fuel, even though it might entail a serious reduction in efficiency? If so then it appeared that as soon as prices recovered there would be a tendency to revert to kerosene. Two questions were therefore, asked and those questions, together with an analysis of the replies, are set out in Table V.

TABLE V.

----	Would you use Gas with Wheat at— 2/- per Bushel ?	5/- per Bushel ?
Yes	51	39
No	7	20
Qualified replies	5	4
No replies	4	4
Total	67	67

The replies suggest that 57 per cent. of those who replied to the questionnaire were satisfied that the reduction in costs secured by converting to producer gas was

not accompanied by corresponding reduction in efficiency. Two stated that gas would be used in preference to kerosene but that crude oil would be preferred to either. This is an important point but until some definite cost figures have been collected in connection with tractor surveys, at present in progress, comment will be withheld.

SUMMARY AND CONCLUSION.

An attempt has been made to review the present position of producer gas as a source of power for farm tractors in Western Australia. The information was obtained from 67 replies to a detailed questionnaire sent to operators, and from personal visits and interviews by the writer.

This report is supplementary to investigations at present in progress at the Engineering School into the mechanical problems associated with producer gas and at the Institute of Agriculture into the costs of operating tractors under wheatbelt conditions.

Interest in producer gas as a tractor fuel was aroused in Western Australia as a result of depressed wheat prices after 1930. Numerous attempts were made to design and construct plants but the majority were not successful.

By December, 1937, the number of plants in operation declined to about 62. Owing largely to the appearance of another make on the market the number has now increased to over 200 or about 5 per cent. of the tractors in the State.

As applied to the ordinary kerosene tractor engine producer gas has entailed an increased capital expenditure, some reduction in power and consequently in the time taken to perform a given amount of work, a decrease in reliability and certainty of operation, more intelligence and knowledge required for successful operation, in some cases a decrease and in others an increase in costs of depreciation and repairs and renewals to the tractor itself and some increase in the daily service work necessary. On the other hand it has affected considerable savings in fuel and oil costs.

The extent to which the disabilities offset the advantages have varied greatly from farm to farm and will continue to do so. Technical improvements have been and will continue to be made that reduce the degree of some of the disabilities mentioned above, but there are some that can never be completely overcome. The decision as to whether the advantages of gas outweigh the disadvantages attached to its use will be determined by the type of tractor and the purposes for which it is used, the way in which it is used and the type of man who will operate it.

There is at present ample scope for continued research into the mechanical problems connected with the use of gas particularly as interest will be heightened in it by the prospective low prices for wheat.

Instances were encountered where operators would have benefited by improved service by the sellers of plants, though whether this would have been economically possible for the sellers is another matter.

It also appeared that the establishment of a school of instruction, where operators could learn the correct method of handling their plants and how to detect and remedy faults in their early stages, would be of value in extending the popularity of gas producer attachments.

At present it is mainly a case of learning by experience, and the success or otherwise of the gas-driven tractor is dependent on the skill, intelligence and adaptability of the operator to a greater extent than it is with a kerosene tractor.

In conclusion the opportunity is taken of thanking the many people who have assisted by contributing information for this survey. The writer is particularly indebted to Associate-Professor Bowden, who is directing the research work connected with producer gas in the Engineering School of the University of Western Australia, without whose help and advice a considerable portion of this paper could not have been written.

APPENDIX I.

Analysis of Substances taken from Producer Gas Generator and Cylinders of Tractor.

Analysed by R. J. Harvey,
Institute of Agriculture, University of Western Australia, July, 1938.

Producer Deposit—

White Powder.

		%
Loss of ignition (includes CO_2)		5·1
CaO		84·5
MgO		10·1
Insolubles ... ... trace	Not estimated	0·3
Cl ... ... „		
PO_4 ... ... „		
Fe_2O_3, Al_2O_3 ... ... „		
		100·0

The deposit thus consists almost wholly of calcium and magnesium oxides which have probably become carbonated to some extent after sampling.

Cylinder Deposit—

Brownish-black Scales.

		%
Loss of ignition		37·6
Fe_2O_3		14·7
Ca		5·3
Mg		2·6
SO_4		10·9
Cl		14·1
Na		12·9
Insolubles ... ... trace	Not estimated	1·9
PO_4 ... ... „		
Zn ... ... „		
		100·0

APPENDIX II.

Western Australian Government Railway's Milage Rates for Goods per Ton.

(Rates for manure and firewood are inserted for comparison.)

SPECIAL CLASSES.

Miles.	Manure.	Firewood.	Miscellaneous Class.	A Class.	C Class.
	per ton.	per ton.	per ton.	per ton.	per ton.
	s. d.	s. d.	s. d.	s. d.	s. d.
1 to 10	2 6	2 7	2 6	7 6	9 4
30	2 11	4 2	5 0	10 10	16 9
50	3 3	6 2	7 0	13 8	21 9
70	3 6	7 0	8 8	16 0	25 8
90	3 11	7 10	9 9	18 0	29 9
110	4 4	8 8	10 11	20 0	33 7
130	4 9	9 6	12 1	22 1	37 5
150	5 2	10 4	13 3	24 1	40 11
170	5 7	11 2	14 5	26 1	44 9
190	6 0	12 0	15 7	28 1	48 7
210	6 5	12 10	16 8	30 0	52 1
230	6 10	13 8	17 8	31 9	55 3
250	7 3	14 6	18 8	33 4	58 3
270	7 8	15 4	19 8	35 2	61 5
290	8 1	16 2	20 8	36 11	64 7
300	8 3	16 7	21 2	37 8	66 1

Charcoal in bags in less than two ton lots is charged at the Class C rates, over two tons it comes in Class A and if loaded in wagons to their full carrying capacity it comes into the much lower miscellaneous class. It is obvious, therefore, that if charcoal has to be trucked for any distance a big saving can be made by buying truck loads instead of small quantities.

THE CONTROL OF BOVINE MASTITIS.

A General Discussion of the Problem, together with Results Obtained in Local Conditions.

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E. F. Twaddle, M.R.C.V.S., Veterinary Surgeon.

Definition of the term "Mastitis."

The term "Mastitis" signifies an inflammation of the mammary gland or udder. In the mildest cases it is shown only by an increased leucocyte content of the milk. If not due to a mechanical injury, some micro-organisms also should be present in the udder. In severe cases the affected quarter or quarters may be swollen and inflamed. In case of long standing, invasion of the udder tissues generally takes place, and hardened masses of fibrosed tissue may be detected by clinical examination.

Obviously, from the definition of the term mastitis, apart from cases caused by mechanical injury of the udder, mastitis may be caused by any organism capable of invading the udder and attacking the delicate internal tissues. Actually mastitis cases are known to be caused by streptococci, staphylococci, organisms of the baterium coli group, brucella abortus and mycobacterium tuberculosis.

The mastitis cases of greatest importance from an economic standpoint are those which are caused by invasion of the udder by the organism, "Streptococcus agalactiae" (syn. "Str. mastitidis"), for such cases apparently never recover completely, even though periods of apparent normality are experienced; and, as the disease is infectious, the affected animals are a menace to the clean members of the herd. The majority of mastitis cases are of this type.

Constitutional Symptoms of Mastitis.

In cases of acute mastitis the constitutional symptoms appear suddenly. Often a shivering fit is the first symptom noticed by the owner. The animal is restless, pulse frequent and the temperature if recorded at this stage is high, often up to 108 deg. F. Appetite and rumination are temporarily suspended. The cause of the trouble may not be suspected until the udder is examined and the inflammatory changes and secretary derangement are then detected in the organ.

The Detection of Mastitis.

(1) Clinical Tests.

The clinical cases are those which are most readily detected. In bad cases the affected quarters are swollen, inflamed and painful. The milk from such quarters may be thick and ropy. Sometimes it may show little or no resemblance to milk, being a thick, semi-gelatinous secretion of a yellowish or brownish colour. At times the secretion is a thin, somewhat clear, brownish fluid. In the cases where the acute or inflammatory stage has passed the secretion may again appear nearly normal, but it often contains white or cream coloured "clots" of varying size. The clots may be sufficiently large to be readily recognised, or may be so small as to be difficult to see; such small "clots" are more readily seen by collecting some of the milk on a glass plate, allowing most of it to drain off and then examining the plate in a good light.

In old chronic cases fibrosed areas may generally be detected by palpation of the udder after it has been thoroughly stripped.

(2) Colour Tests.

The colour test method for the detection of mastitis has been shown to be far too unsatisfactory in the results it gives to have any real practical value. This test method has been discussed previously in this Journal. (Jr. Dept. Agric. W.A., XV. (Second series), 3, 281).

(3) The Catalase Test.

Catalase is an enzyme which is contained in the leucocytes. Thus, an estimation of the catalase content of the udder secretion is an indirect estimation of the leucocyte count and, insofar as one considers that leucocytosis is synonymous with mastitis, this test should be an accurate test for mastitis.

To test for catalase use is generally made of its property of decomposing hydrogen peroxide with consequent liberation of oxygen.

The most simple method of conducting the test is that described by Orla-Jensen (Dairy Bacteriology). A graduated tube of 20 ml. capacity is fitted with a rubber stopper and S-shaped pieces of glass tube. 15 mls. of milk are introduced into the tube and sufficient hydrogen peroxide (1-3 per cent.) is added to fill it. The stopper with its tube is replaced and the apparatus inverted. The number of mls. of oxygen evolved in six hours at room temperature is taken as the catalase number.

A variation of the test to give a colour indication has also been proposed (Vet. Med. 32, 20-21, 1937). The variation in colour obtained when P-phenylenediamine hydrochloride is added to the mixture of milk and hydrogen peroxide is noted. Normal milks produce a blue colour, mastitis milks no colour.

The data presented in the literature shows no close correlation between leucocyte counts and catalase numbers. However, such cannot be expected, as a smear of milk, by chance containing a spot of pus, will show a very large cell count relative to a smear containing no spots of pus prepared from the sample. The obtaining of an average cell count in such cases is almost impossible. Further, the agglomeration of the leucocytes into masses in the pus accentuates the difficulty, and a variable percentage of the total cells will be cells other than leucocytes, such as epithelioid cells.

The data, however, does show a general tendency for high cell counts to run parallel with high catalase numbers. It also indicates that a cell count greater than 100,000 per ml. or a catalase test greater than 2.5 mls. of oxygen (obtained according to the above technique) is a good indication of udder infection. The tendency is to accept these limiting values for the cell count and catalase numbers as indicators of udder infection.

It should be noted that, as the catalase test is obtained with a sample of milk relatively large to the quantity used for the direct microscopic examination test, it should give a more average indication of the degree of abnormality of the milk.

The catalase test has not been utilised in the local investigation for the reason that, although it is apparently a good method for detecting milk samples which have a high leucocyte content, i.e., milk samples drawn from mastitis quarters, it gives no indication of the type of infection which is present.

Other chemical tests have been proposed for the purpose of detecting mastitis infections (e.g. the chlorine concentration of the milk), but these tests appear to have a less fundamental basis than the catalase test and to give less accurate results.

(4) The Microscopic Examination of the Milk.

The method used by the writers for the microscopic examination of the milk has been previously described (Jr. Dept. Agric. W.A., XV., second series, 3, 281), but for the purpose of keeping this paper complete in itself, the description of the method will be included.

The mastitis cases which the bacteriologist generally wishes to detect are those caused by streptococci. The number of organisms in the milk from such mastitis quarters is very variable; in acute cases the number may be many millions per ml. but in chronic cases there may be so few as to be easily missed upon microscopic examination. To be more sure of detecting the streptococci it is preferable to give the milk samples a preliminary incubation at 37° C.

The following method of making the test has been followed by the writer with excellent results (Jr. Dept. Agric. W.A., XV., second series, 3, 281):—

"The selective bactericidal properties of certain dye-stuffs is well known, e.g. gentian violet at a concentration of 1 : 100,000 inhibits the growth of most Gram-positive organisms but allows the growth of most Gram-negative species. The use of brilliant green at a concentration of 1 : 50,000 to obtain a selective growth of the streptococci causing contagious streptococcic mastitis was suggested by Bryan and Huber (Bull. Inst. Past. Rev. et Anal. XXXIII., p. 1112), and is used in this laboratory.

Sterile bottles, with a mark to show the level reached by approximately 50 mls. of liquid, are used as sample bottles. Five mls. of an "aged" solution of brilliant green is added to each bottle, the addition being carefully made to maintain sterility. The "aged" solution of brilliant green is prepared from Grubler's dye and sterilised distilled water prepared in a still fitted with a block-tin condenser. The concentration of dye in the solution is 1 : 5,000. The solution is kept for at least two weeks before use.

Before collecting the milk samples three or four streams of milk are discarded. The bottle is then filled to the 50 ml. mark. Separate samples from each quarter are taken and all precautions to avoid the entrance of extraneous organisms are observed.

The samples are incubated overnight in the 37° C. incubator. The time of incubation is about 18-20 hours.

Smears are then prepared for microscopic examination according to the method used for the "direct count," as described in Journal Dept. Agric. W.A., XIV., March, 1937, pp. 65-73, Leaflet 504.

Samples showing the presence of leucocytes and long chain streptococci are classed as "mastitis positive." Samples showing leucocytes in excess of 100,000 per ml., but no streptococci, are classed as "mastitis doubtful." Samples showing no streptococci and having a leucocyte count of less than 100,000 per ml., are classed as "clean."

The significance of this classification will be discussed directly, together with a discussion of its importance in the control scheme.

The Treatment of Mastitis.

Many claims have been made for various treatments for the cure of mastitis. Treatments advocated include fomentation and massage, etc., irrigation of the udder with antiseptic solutions, and the use of vaccines, etc.

As regards the fomentation and massage treatment, it may be said that its only value lies in relieving the suffering of animals during the acute stage of the disease and possibly hastening the cure of animals affected with a very mild form of mastitis, other than streptococcic.

For the second method of treatment two antiseptics in particular have been advocated. These are known as "Entozon" and "Acriflavine." "Acriflavine," which is well known as an antiseptic in medical practice, would appear to have great possibilities because its germicidal activity, contrary to the usual finding with antiseptics, is enhanced in the presence of serum.

The following figures show the concentration of "Acriflavine" necessary to inhibit the growth of Staph. aureus and B. coli. (Extra Pharmacopoeia XX., Vil. II., 1935, p. 648).

Organism.	Concentration in 0·7 % Peptone Water.	Concentration in Serum.
Staph. aureus	1 : 2 x10^4	1 : 2x10^5
B. coli	1 : 1300	1 : 10^5

Encouraging results have been reported with these substances, particularly "Acriflavine," in England. (Vet. Record 50, No. 23, June, 1938, p. 663.) On the other hand experiments carried out locally by the writers have so far given disappointing results.

Many experiments have been conducted with vaccines. As a result of a general survey of the literature prior to their work, coupled with their own findings, Plastridge et alia concluded that such treatments were unsatisfactory (Agric. Expt. Stn. Storrs Conn. Bull. 197 (1934)). The following quotation is taken from the summary in that bulletin:—

"In general, the results obtained with bacterins, show that (1) periodic injections of autogenous herd bacterins fail to bring about complete recovery of affected animals; (2) they reduce but slightly the rate of spread of infectious mastitis; and (3) they apparently aid somewhat in retarding the occurrence of milk abnormal in appearance by animals recently affected with the disease.

Evidence of recovery was no greater in treated than in untreated animals and was limited almost entirely to those affected with staphylococcal mastitis or mastitis due to infection with group B streptococci. Instances of recovery in animals affected with mastitis due to group A streptococci (which appears to be the principal cause of mastitis in Connecticut herds) were rare."

The Control of Mastitis.

It has frequently been shown that troubles caused by bacteria are largely avoided by paying close attention to certain fundamental principles. Whether the trouble is an animal disease, such as mastitis, or the decomposition of a foodstuff, such as the souring of milk, or any other trouble of bacterial origin, the same fundamental principles apply. The measures taken regularly to prevent the spread of infectious diseases, such as, for example, "diphtheria," are based upon these principles. The principles may be enunciated as follows:—

I. The foci of infection must be isolated or preferably eliminated.
II. The causes of the transference of the bacteria must be removed.
III. Conditions unfavourable for the growth of the organisms should be induced in the animal or foodstuff it is desired to protect.

The manner in which the principles are carried out may readily be followed in the example above mentioned, *i.e.* diphtheria. To comply with the first condition all persons found to be infected are quarantined. To avoid the transfer of the bacteria and thus avoid spread of the disease, all persons who have made contact with cases of the disease are also isolated until proved free of infection. To comply with the third condition, people in a locality infected with diphtheria are advised to have themselves inoculated and so immunised against the disease.

Encouraging results obtained by the application of so-called "sanitary control measures" have been reported in the literature dealing with mastitis. The following abstract is an example taken from the summary in Bull. 197 of the Agric. Expt. Stn. Storrs, Connecticut (1934).

"Bacterin was used in Herd F. for two years and then discontinued. Segregation and disposal of affected animals and sanitary control measures were then practised. The incidence of mastitis during the first and second year was 33.3%

and 29.4% respectively. During the third year it dropped to 16.6% and 3·8% at the beginning of the fourth year."

An experimental control scheme based upon the above-mentioned principles was commenced in one of the local herds early in 1937, and the results obtained will now be discussed.

The Initial Condition of the Herd.

The history of mastitis in this herd dates back for at least 10 years, and, when the farm was first visited by the writers early in 1937, apart from the infected animals found in the milking herd, a number of the worst cases were noted as being isolated in one of the farm paddocks.

When first tested 37 cows were present in the milking herd. Fourteen of these animals were found to be definitely affected with streptococcic mastitis, by the microscopic test method as described above, whilst six gave milk (from one or more quarters) which had a high cell count, but in which no streptococci could be detected. They were classed in the "mastitis doubtful" group. (It should be noted, of course, that the term "mastitis doubtful" means doubtful as regards streptococcic mastitis, but this will be discussed more fully directly.)

The six cows which gave the high cell count milk were apparently all intermittent shedders of streptococci: or, the streptococci in the milk were so few that none were contained in the samples, for each of the six cows were found to be infected with streptococcic mastitis in later tests. It is interesting to note that four of these animals had clinical indications of mastitis and/or a history of udder disturbances. Also, among the animals which gave no indications whatsoever of udder infection by the microscopic test method, were three with clinical indications of mastitis and or a history of mastitis. These three animals also gave definite indications of streptococcic mastitis by the microscopic test method when later tests were carried out.

The latter findings indicate a very important point, which is, that animals showing tissue changes of the udder upon clinical examination together with animals having a history of mastitis should be segregated from the definitely healthy animals even though no indications of infection are obtained by the microscopic test method. It would appear that the streptococci may be very firmly isolated in fibrosed areas and thus not necessarily found in the bulk of the milk from the quarter.

At the time when the first test was carried out a number of animals were not in milk and these must next be considered. Excluding heifers introduced into the milking herd for the first time after the control scheme had been started, there were six such animals. Four of them were found to be definitely affected with streptococci mastitis when first tested. The other two animals showed no evidence of mastitis and have remained clean.

Summarising these results, it will be seen that in the milking herd comprised originally of 43 animals there were 27 animals which were affected with streptococcic mastitis, *i.e.*, the incidence of infection was 62.8 per cent.

There were no animals more than four years of age which had not become infected, *i.e.*, no animal had reached the third lactation period free from infection. Further, among the infected animals which were noted up to the time when control measures were first instituted, there were nine infected animals on their first lactation period.

Control Measures Discussed.

It should be obvious that, if either of the first two principles above-mentioned could be perfectly applied, or, in connection with the third principle, an immunity

could be established in the clean members of the herd, the spread of streptococcic mastitis would be stopped. However, none of these desirable conditions can be perfectly attained, and it is thus necessary to apply all three as rigidly as possible.

First Step in Control: The Removal of the Foci of Infection.

Many difficulties arise when an attempt is made to eliminate all animals affected with mastitis. The initial difficulty is that of actually detecting the disease in all animals affected. Some indication of this problem has already been given. Infected animals are of several types.

(1) Those animals which produce milk which, examined by the microscopic method as detailed above, is found to contain an abnormal number of leucocytes together with typical long-chain streptococci. The detection of these animals offers little or no difficulty.

(2) Other animals are found whose milk shows no sign of abnormality, but which have tissue changes in the udder detectable by an experienced veterinary surgeon. Those cases noted by the writers in this group eventually gave a positive microscopic test and it is considered that probably all such animals should be classed as affected. As previously mentioned, the streptococci appear to be very firmly held in the fibrosed areas and it may be some time before they are detected in the milk samples.

(3) A third type includes those animals which give milk having a high leucocyte content, but in which no streptococci can be detected. These animals form the worst cases to deal with for an extended series of tests becomes necessary. In the herd under survey only one such animal having no detectable tissue changes and no history of mastitis, was noted. This animal secreted milk in which streptococci were observed when a second test was taken, three months after the first test. This animal was probably one of the so-called "intermittent shedders of streptococci" mentioned in the literature. Probably the explanation is that the number of organisms present in the udder is so small that none happen to be present in the sample which is collected.

However, it is not possible to class all animals which secrete milk having a high leucocyte content as positive streptococcic mastitis cases. The writers believe that, insofar as mastitis is merely an inflammation of the mammary gland or udder, a leucocytosis of the milk is just as accurate an indication of inflammation of the udder as a leucocytosis of any other portion of the body is an indication of inflammation of that portion, and any animal secreting milk with a high leucocyte content should be classed as affected with mastitis. But, as previously stated, inflammation may be caused by many organisms other than streptococci. It is not proposed to spend much time and space reviewing the large amount of literature on this subject. The following histories of two animals are sufficient, it is thought, to illustrate this opinion.

COW NO. 1—AGE 2 YEARS.

Date Tested:	6-4-37	14-7-37	13-10-37	3-11-37
Findings ...	..	..	R.B.	..
Date Tested:	9-3-38	25-4-38	27-6-38	16-8-38
Findings ..	..	..	R.B.; L.B.	..

COW NO. 2—AGE 3 YEARS.

Date Tested:	6-4-37	3-11-37	29-11-37	17-1-38
Findings	R.F.; R.B.; L.B.	R.F.; R.B.; L.F.; L.B.	...	...
Date Tested	9-3-38	25-4-38	27-6-38	16-8-38
Findings	R.B.	R.B.	...	...

In the above tables are indicated the quarters of the animals which secreted milk with a high cell count on the test days indicated.

It would seem that the leucocytosis is caused by some very mild infection which the animals are able to overcome by their normal defensive methods.

An interesting observation was made in this connection. Approximately six months after the commencement of the control scheme a severe outbreak of vaccinia (cowpox) occurred in the herd, practically all the animals being affected. Shortly after the outbreak the milk samples were tested and all showed a very high cell count. The cells appeared to be mainly degenerate polymorphonuclear leucocytes. The cells gradually decreased in numbers during the following few weeks and it would seem that the high cell count of the milk samples and the incidence of vaccinia should be correlated.

Considering next the disposal of animals which have been diagnosed as affected with the disease, one is liable to encounter further difficulties. In the first place, the incidence of mastitis in a herd is generally very high. (In the particular case under discussion it was found to be 62.8 per cent.). Thus the elimination of all the affected animals would reduce the size of the herds in many cases to a small proportion of the original size. For several reasons it will generally be impossible to replace the affected animals immediately. Firstly, the actual cost of replacement must be considered; secondly, the loss of high class breeding animals must be taken into account; and thirdly, the difficulty of obtaining disease-free animals for replacement purposes.

Taking everything into consideration, it would appear that the most sound procedure to adopt is to rigidly isolate the affected animals of the herd. Such animals are then available for breeding purposes, a particularly important point where highly bred pure blood stock has to be considered. The disease is not transmissable to calves during the early months of their lives and the isolated animals may be allowed to rear their own progeny. However, as soon as sufficient disease-free stock is available to meet the minimum requirements of a farm the affected animals should be disposed of to reduce the risk of infecting the new herd.

Second Step in Control: The removal of Causes of Transference of the Organism.

The measures to be taken in connection with the second principal above mentioned must next be considered. It is generally considered that the main agents causing the spread of mastitis are the hands of the milker, or, where machine milking is employed, the teat cups of the machine. The preventive measure to be instituted is obvious, i.e., the careful sterilisation of the milker's hands or teat cups of the machine, as the case may be, between the milking of the animals. When

hand milking is employed, the hands of the milker may be washed in a suitable disinfectant. However, when machine milking is employed the sterilisation of the teat cups is not so simply achieved. Probably the best treatment would be to immerse the milking claws in a copper of boiling water for several minutes between the milking of each animal. It has been argued with the writers that such a procedure results in losing the main advantage of machine milking, but one can hardly expect to control the mastitis in a herd without taking some trouble over the necessary control measures.

The milking of the animals in succession according to the chance of their being free from infection, is one of the most important steps in a control programme in that it reduces the chance of spreading infection. Generally, the same milkers will be required to attend all the animals. When this is the case the milking order should be—

(1) Group I. animals, i.e., animals definitely free from infection at the last examination.

(2) Group II. animals, i.e., animals with a possible streptococcic infection and definitely some type of udder disturbance—those animals classed as "doubtful" according to the previously mentioned method of classification.

(3) Group III. animals, i.e., animals definitely affected with streptococcic mastitis which have been retained for breeding purposes.

A second obvious agent for the spread of the disease is, of course, the washing equipment used for cleaning the udders prior to milking. The wash water should contain some proved antiseptic at a suitable concentration, and care should be taken to ensure that the concentration of the disinfectant is maintained. Solutions of such materials as the chlorine disinfectants, e.g., calcium hypochlorite, i.e., bleaching powder, being strong oxidising agents, rapidly deteriorate in strength due to the organic matter introduced into them during the washing process, and, therefore, require to be frequently renewed.

Flies have not been proved to be carriers of infection, but obviously the possibility that they are carriers exists. To avoid the attraction of these insects to the udders, the udders should be washed in antiseptic solution after the completion of the milking process to remove all traces of adhering milk.

When calves are allowed to mix with a number of animals, they also may cause spread of the disease by indiscriminate sucking, and, therefore, steps should be taken to ensure that calves cannot mix with clean animals and affected animals; in fact, it is best that no calves be allowed to suckle from the clean animals.

Third Step in Control: The Building-up of Resistance in the Animals.

As previously mentioned, prophylactic treatment has not been successful in the control of mastitis. (Agric. Expt. Stn. Storrs Conn., Bull. 197, (1934)). The following quotation is taken from the summary in the Storrs Stn. Bull. 197: —

"In the College Herd, Herd C, the average incidence of mastitis for a four year period was 40.5 per cent. in the treated group and 51.2 per cent in the untreated group.

In Herd B, the incidence of mastitis in the bacterin treated group, was 50 per cent. during the first year and 40.9 per cent. during the second year. The control group showed an incidence of 40 per cent. during the first year and 39.1 per cent. during the second year."

Insofar as the maintenance of the herd in good condition mitigates against attack by any disease, this fact should be given attention. The writers' observations lead them to believe that exposure of the animals to cold, wet conditions increases the incidence of mastitis amongst the animals.

Hereditary Resistance.

Occasionally a few cows are found whose resistance to streptococcic mastitis apparently greatly exceeds the resistance of most members of the herd. Thus, one may find occasional animals of about twelve years of age perfectly free from any evidence of infection, notwithstanding the fact that they have passed the whole of their existence in a large herd where the incidence of mastitis is between 60 per cent. and 70 per cent. Some workers claim that strains of animals are to be found showing this characteristic.

The reason for this supposed resistance of certain animals is unknown. It should not be forgotten that, even regarded on a probability basis, a few animals would be expected to remain free from infection during the whole of their lives. If, however, freedom from infection of a strain of animals is proved, hereditary resistance must be accepted as an actual fact. The evidence to date points in this direction.

Either or both of two possibilities may explain an hereditary resistance. The first possibility is a serological reaction: the second, an anatomical structure of the teat itself. Little or no work has been published in connection with the first possibility, but an important paper on the anatomy of the teat of the cow has been published by Johnson (Jr. Path. and Ther. 51 (1938), p. 69). Apart from variations in the size and shape of the duct itself, this worker has noted the presence of variable numbers of small pouches and folds in the delicate epithelial lining of the sinus itself. By means of experiments carried out with carbon particles and water, it was shown that the pouches could act as lodging places for small particles, and also that small particles could be dislodged from the pouches and forced back from the sinus into the upper areas of the udder by certain manipulations of the teat.

The Experimental Procedure.

In the experiment conducted locally samples were collected from each of the animals in the milking herd. Three or four jets of milk from each teat were discarded and then separate samples collected from each. From the results of the examination of the incubated samples, the herd was then classified as described above. Note: Hand milking was employed at the farm. The following recommendations were made:—

(1) Prior to milking, the udder of each animal was to be well washed in an antiseptic solution after the milker had thoroughly washed his hands in the same solution. In order that the wash cloths should be well disinfected between each animal, the animals were to be washed one at a time, each immediately prior to milking, and the cloths then left in the antiseptic solution until required for the next animal. These measures were to be instituted at the first milking after the test samples were collected, notwithstanding that the results of the tests would probably not be available until after several milkings had been performed.

(2) The animals were to be milked in the order Group I, followed by Group II, with Group III last, as soon as the classification of the herd was available. The animals of Groups I. and II. were to be allowed in the milking shed together but those of Group III. were to be brought in separately.

(3) After milking the animals were to have their udders re-washed with the antiseptic solution.

(4) After milking, the floor of the shed was to be sluiced down with strong disinfectant solution.

(5) Those animals definitely affected were to be kept segregated from the healthy animals in separate paddocks.

It was proposed to re-examine the animals at intervals of approximately three months and reclassify them according to the new test results obtained. Actually the first three routine tests were separated by approximately this period of time, but subsequent tests were made after the lapse of a shorter period, generally about six weeks. Further, special tests were frequently made of the Group II. animals during the first twelve months of the experiment.

Experimental Results.

During the first nine months following the date of the first classification of the animals, five fresh cases of mastitis occurred among the animals of Group I., i.e., the group containing the definitely clean animals. These five new cases when initially tested showed no clinical signs of any infection, secreted milk free from streptococci and with very low cell count, and had no history of mastitis.

At first it was thought that the control measures were ineffective, but certain information indicated that the control measures advocated had not been adopted and later, definite evidence of this fact was found. e.g.—It was discovered that the milking order recommended had not even been followed.

It was explained to the farm manager that the work would have to be discontinued unless a guarantee could be given that the procedure recommended would be adhered to rigorously, and during the next nine months conditions improved. The animals, so far as is known, were milked in the order specified. The use of disinfectant solutions as recommended was followed, although at times it was noted that the strength of the disinfectant was below requirements. The disease-infected animals were not isolated in fields away from the clean animals, the manager maintaining that with the facilities at his disposal this was not possible.

Even with the poor control measures described, however, the number of fresh cases which developed was only one, which compared with the five which developed during the previous nine months, was a marked improvement.

During the period whilst the control scheme has been in operation, heifers have been added to the herd, bred from both infected and clean animals, bringing the number of animals in the disease-free herd at the end of the second nine months up to 26. Had the programme advocated been carefully followed, it is probable that the six animals which became infected would have remained free from the disease. This would have brought the total number of clean animals to 32. The period reviewed ended just prior to the fresh milking season on the farm and the number of fresh heifers expected for the new season being 12, it will be seen that in two years the herd should have been built up to include 44 animals compared with the initial total number of 43 in the milking shed.

Control Scheme Suggested for General Use.

Every thoughtful dairy-cattle owner wishes to reduce to a minimum the risk of his clean cattle becoming infected. It is suggested that the following control scheme, involving little expenditure and loss of time, should be of assistance to him in that direction.

(1) The animals should be divided into two groups as follows:—

(a) Animals which have never shown any abnormal condition of the udder such as heat, swelling or tenderness, whose udders show no signs of lumps or hardened tissue when carefully examined after stripping, and whose udders have no "light" quarters. Additionally, the milk from the animals must never have shown any abnormality such as "clots," thickness, wateriness or discoloration.

(b) All other animals than those contained in group (a).

(2) The animals in each group starting with those in group (a) are milked according to their age, commencing with the youngest, for the chance of an animal being infected increases with its age.

(3) As new stock comes into production it is added at the beginning of the milking chain, and as fresh animals obtained by breeding can be added to the herd to maintain the minimum output required, others are eliminated from group (b), disposing of the worst cases first. No animals other than heifers, should be bought and added to the herd unless they have been first properly tested and kept isolated from the time of taking the milk samples for test until the results are available.

(4) The hands of the milker, the wash water and cloths, etc., must be treated with antiseptic as described above.

(5) Any animal in group (a) showing abnormality of the milk or the udder after the commencement of the control scheme should be relegated immediately to group (b).

Summary and Conclusions.

For the detection of mastitis, milk examinations in themselves are inadequate. Clinical examinations must be conducted as well as the microscopical examination of the milk samples.

A leucocytosis of the milk, i.e., cell count in excess of 100,000 per ml., is indicative of mastitis, in general, but not of streptococcic mastitis specifically. Results obtained indicate that vaccinia (cowpox) is one of the causes of a temporary leucocytosis of the milk. In the cases noted the cells were mainly degenerate polymorphonuclear leucocytes.

A control scheme, based upon the first principles for the prevention of disease, gives relatively good control of the incidence of mastitis.

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THE BRACKEN FERN AND ITS ERADICATION.

M. CULLITY,
Senior Agricultural Adviser.

Bracken fern is widely distributed over the earth and is probably one of the oldest of plants, dating from cretaceous times. During the long period of its existence it has proved resistant to fungoid and insect attack. Actually in surviving the varying conditions of the changing times, it has proved its adaptability and extreme resistance to haphazard methods of control.

It is a common pest in the south-western portion of this State and throughout many other parts of Australia. In fact it is so common that it is accepted as a permanent resident and frequently no effort is made to control it. It covers hundreds of acres of once cleared land which otherwise could carry useful pastures.

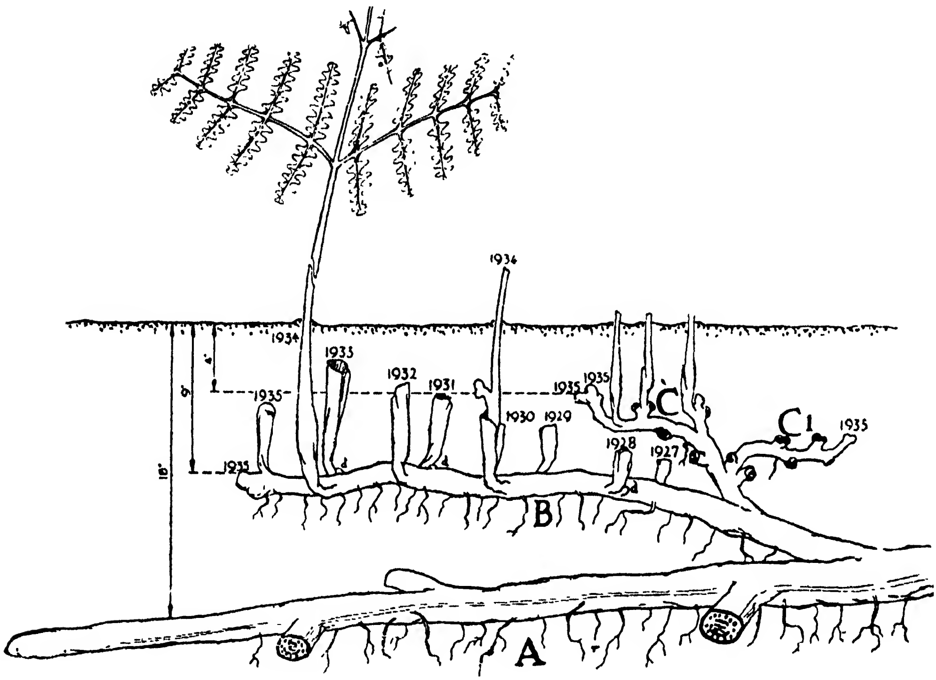
In Western Australia it is gradually occupying increased areas. Its incidence is greatest on those properties with the largest cleared areas and therefore it is easy to understand why more is not heard of the loss of country. In general it may be said that sufficient is known of the methods of control in this State to prevent it from becoming a serious pest on small well-worked properties.

A picture of this plant and its method of vegetative g owth and aggression is best given in the words of K. W. Braid[1]:—

"The bracken plant consists of a bulky underground system which extends for many dozens of square yards. Many a patch of bracken is in fact one extensive plant annually producing hundreds of fronds. Possibly even large bracken areas are all one plant, so it is obvious that the whole must be attacked as a unit. Under ideal conditions of good deep soil the subterranean system can be shown to be made up of three or more tiers of rhizomes or underground stems. The lowest tier —the leader—usually runs at a depth of 15 to 25 inches and is the main invading system. It possesses the thickest rhizomes ending in a terminal finger-like bud which periodically produces side buds to right and to left. This is figured in the diagram as A. The side buds develop into branches which bend upwards and move horizontally in a region above, and if they are within nine inches or less of the surface often bear fronds (B). They also produce subsidiary buds which grow into much thinner, shorter branches, often characteristically zigzagged (C and C1). These approach nearer to the surface and frequently produce fronds in groups. The proportions in which these tiers are produced depend on soil depth and texture and the food ingredients available. Given good friable soil of good feeding quality, tiers A and B are abundantly produced, while if conditions are such as to check these, C develops most. Near the periphery of an area A and B are most abundant and tier C commonest about the centre. If for any reasons the depth of soil decreases, as for example when the subsoil of a rock approaches within seven to nine inches of the surface, all these zones get compressed into one layer overlying the subsoil, but the downward tendency of the terminal bud on A is such that if it reaches deeper soil three or even four tiers will again be exhibited. In all cases the terminal bud of each tier is the most active growing bud. By the division of the terminal cell it gives rise to lateral buds producing either branches or fronds. These may produce buds which may lie dormant for some years. Normally the fronds of each season arise from the side buds immediately behind the terminal buds of tiers B and C, but sometimes subsidiary buds may also develop at the base of these.

"If the frond is destroyed in the green state, the bud destined for next season's frond begins to develop and in addition some of the dormant buds or subsidiary buds develop into fronds."

The fact that the rhizomes are in tiers at varying depths explains how the plant survives the heat of summer. Water in large quantities is needed to replace that lost by transpiration and this can always be obtained by the deepest rhizomes, and with this water it also obtains much mineral food.



BRACKEN: UNDERGROUND SYSTEM IN JANUARY.

A. Main elongating rhizome.
B. Large branch bearing fronds from near apex.
d. Dormant buds. The remains of 1934 fronds extend to surface; those of previous years in various stages of decay. In one case a branch from a dormant bud had grown through an old frond-base.
C. Branch of limited growth; fronds as in B.
C1. Except at end only leaf-scars are depicted.
r. Roots.

From the Scottish Journal of Agriculture, April, 1935, p. 122.

"The bulk of the rhizome may be enormous, five or even ten or more feet of it lying below each square foot of surface. This is packed with food reserves such as sugars and starch. All these food reserves are manufactured in the fronds from the carbon dioxide in the atmosphere and the water and minerals absorbed from the soil.

"The removal of the fronds therefore (a) prevents the building up of further foodstuffs, (b) exhausts the underground reserves by inducing attempts to produce new leaves. Theoretically (and this is backed by experiment), the best time to destroy the fronds is when they have reached their maximum growth, *i.e.*, when they have drained the rhizome but have not begun to contribute food."

This statement agrees with the conclusions reached from observations in this State, that the optimum time for cutting is at the end of spring when the fronds have made full growth. There is always a smaller crop of young fronds after cutting at this time than after cutting at any other period of the year. Where two cuttings per year are carried out, one in October-November when the fronds are at full growth and another in May-June the depressing effect on the plants is greatest. Cuttings in January, February or March appear to have little effect in reducing the thickness of the succeeding crop. Cuttings from May to September result in a fairly large crop of young fronds, but when this is followed by another when the plant is at full growth a greater effect is obtained.

That the removal of the fronds will cause a depletion of the rhizomes is confirmed by examinations carried out by Smith (2):—

"When the rhizomes from the trial holes were examined, depletion of the larger storage rhizomes was evident. Those from an uncut area were large and plump and hard for large distances and only old parts showed decay. Rhizomes from the cut plots were shrunk from a short distance behind the growing point, and they contained a milky fluid instead of the firm white tissue of normal bracken."

Hendrick[3] showed by a series of analyses that the amount of food reserves as expressed by soluble carbohydrates and nitrogen, diminishes steadily up till the time of maximum growth of the fronds, after which there is again an increase.

The starvation of the root system is also demonstrated by the diminishing size of the fronds.

There can be no doubt that the cutting of bracken is the most effective method of attack, but unfortunately this method cannot always be economically applied.

An outline of the procedure which it is suggested should be followed is given hereunder. For convenience it is proposed to consider an area of partially cleared country and to follow its progress from a bracken infested area until it is an area of open pasture. A consideration of bracken in virgin country will not be made as in these conditions it cannot be described as a serious pest, and the method of attack necessary to subdue it would be an expensive one. Usually, however, the bracken does not assume the proportions of a pest until some preliminary clearing is carried out allowing more sunlight to reach the areas where the outpost plants are existing.

If it is impossible to commence clearing the area more thoroughly and it is necessary to attempt a reduction in the amount of the pest, the following methods may be applied.

Fire.—In areas such as those under consideration it is possible almost every year to get a fire to go through the paddock burning the dead bracken and at least killing the green fronds. It is more usual to burn every second or third year when a more intense fire and a cleaner result can be obtained. Experience has shown, however, that this method of control is totally ineffective as a means of eradication of bracken unless it is combined with certain other steps. It can only be considered as a method justified by expediency, inasmuch as the pest is not actually checked but the ground is cleared of the dry debris. As a consequence young grass is allowed a slightly more clear space in which to grow, and stock will be able to make their way more easily through the areas so treated. This method is of course usually restricted to large paddocks.

Pasture.—Good results have been obtained by sowing subterranean clover seed on the ashes after a burn as described above, and topdressing with superphosphate. The clover usually is able to make rapid development until such time as the bracken

growth and debris again is smothering the area and another fire is needed. This growth of clover entices stock into the area which then assist in counteracting the pest by their eating or trampling the young fronds.

Cutting.—A further step which is occasionally taken in conjunction with the above is the use of the fern hook to clear the area periodically. This entails either the gathering of the fern into heaps for burning or recourse to a running fire, to clear the ground. The employment of the fern hook will depend for its efficiency on the time of the year that it is used.

Subdivision.—While the methods referred to above will gradually open up the paddock, the erection of subdivisional fences will assist in speeding up the attack. The trampling effect of the stock by being localised will be more severe, and it will be easier to carry into operation a plan for more offensive methods.

Clearing.—The clearing of the stumps and fallen trees must be carried out before it can be hoped to fully subdue the fern. The ground is then ready for the plough, and it is usual to sow a crop of some sort in order to level the ground sufficiently for the use of the mower. As a means of subduing the fern the plough is not as effective when used before a period of cutting as it is when used after. The deepest rhizomes are untouched and remain vigorous to take up the attack. After a series of cuttings the higher rhizomes are weakened and the lowest which usually do not produce fronds commence to grow towards the surface so that the production of fronds may be continued. It can be easily realised therefore that a ploughing after a period of cutting will be much more effective in breaking up the whole of the rhizome system.

Mowing.—The ground after having been ploughed and cultivated will be in a level condition and fit for the use of a mower. The system of attack by cutting can then be carried out with this implement. Unfortunately the optimum time for doing this work coincides with one of the busiest periods on a farm, the harvest. That cutting at this period is effective is proved by the fact that the bracken does not survive if a paddock is cut two or three times for hay.

Old Pasture.—Where it is desired to reclaim old pasture which has been allowed to succumb to the advance of bracken, the method to be adopted will vary according to the density of the growth. Assuming the field to be densely covered it is suggested the best results would be obtained by following the steps suggested hereunder or variations thereof:—

(a) clear the paddock of the accumulation of dead bracken by burning during the late summer.

(b) If subterranean clover is not present sow on the ashes up to six pounds of inoculated clean seed or an equivalent amount of burr per acre, the rate depending on the original density of the bracken. Six pounds per acre will give a complete cover in the first season.

(c) Fertilise with at least one hundredweight of superphosphate per acre.

(d) Stock lightly, allowing the clover to seed.

(e) Mow the paddock in November even if the hay crop be unsuccessful.

(f) In the following autumn mow the regrowth of bracken, fertilise with superphosphate and allow stock to graze more heavily.

(g) Close the paddock early and cut for hay.

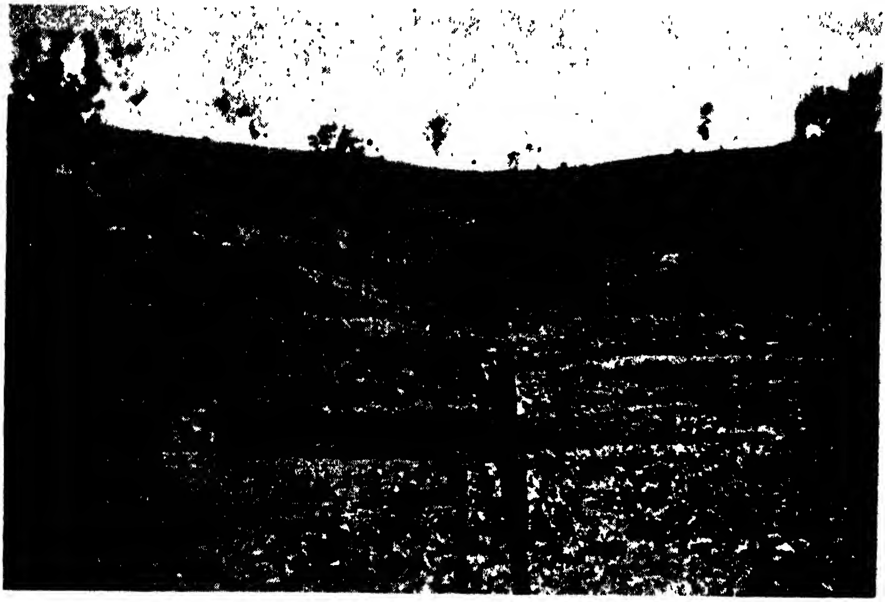


Fig. 1.—Partially cleared country, rendered temporarily useless by a heavy growth of bracken.

Fig. 2.—A fully cleared hillside, completely covered with bracken. Clearing fires have not checked its growth.

The process of cutting twice annually should be continued for two seasons, when the densest bracken will have been severely checked. If preferred after two seasons' cutting, a crop could be sown and the ploughing necessary would be effective in cutting to pieces the weakened rhizomes, which would have been drawn closer to the surface.

Other Methods of Attack.

Whipping has been carried out in certain countries, particularly France. There does not appear to be any very definite information available as to its efficiency. There can be no doubt that the bruising effect particularly during the growing period would weaken the root system. As far as can be ascertained the comparative effects of cutting at the optimum time and whipping have never been studied.

Fig. 3.—Subterranean clover growing vigorously amongst bracken. The trampling of the stock has effected a great reduction in the density of the plants.

Rolling.—Much is claimed for the effectiveness of various types of rollers and drags. Some of these are fitted with chopping blades of different kinds. Rolling requires clean open paddocks free of stumps and fallen trees, and in these circumstances cannot be more successful than the mower. Further, the best time to use the roller is when the fronds are young and brittle. This allows a later growth of fronds in the same season and so a series of rollings would be required.

Pigs.—The use of pigs that have not been nose rung is quite successful. The animals like the succulent roots and will turn over much ground in order to reach them. It is obvious however that their use on a large scale for this purpose is not practicable.

Weedicides.—Much more promise is attached to the possibility of attack with weedicides. As the clearing of bracken is undertaken primarily to allow utilisation

of the ground for other plants, the selection of a weedicide is limited to those which, while destroying the plants will not injure the soil. Among the substances capable of performing the work the chlorates of sodium and calcium are the most useful. It has been demonstrated by Braid and others that it is possible to get a complete kill, of both fronds and roots by a single application of sodium chlorate. For this

Fig. 4.—Bracken being beaten back from pasture. In the foreground the clear space has been mown for hay during the past two seasons. The headland along the fence is still carrying vigorous plants. In the background the fern has been cut by the mower.

purpose a dressing of not less than two hundredweights per acre is required. As the chemical is high in price this method is, temporarily at least, prohibitive. Another system is the application of sodium chlorate direct to the cut stalk of the frond by the use of a piece of sponge rubber saturated with a solution of the chemical, attached to the blade of a scythe or to the cutter bar of a mower. This system is claimed to be fully effective and uses only a small amount of the chlorate. As the cost should be of a range to allow of its adoption on a wide scale, arrangements are being made to carry out trials in this State.

References:—

[1] K. W. Braid—'Scottish Journal of Agriculture,'' Vol. XVIII., No. 2.

[2] W. G. Smith—Trans. Bot. Soc., Edinburgh.

[3] J. Hendrick—Kew Bulletin, No. 4, 1921.

SOME EFFECTS OF GREEN MANURING ON CITRUS TREES AND ON THE SOIL.

I.—INTRODUCTION.

In 1924, a permanent green manure experiment was begun in a newly-planted citrus orchard at the Commonwealth Research Station, Griffith. The purpose of this Bulletin is to report the results that have been obtained concerning the effect of various treatments on the growth and yields of the trees and on the fertility, structure and water-holding capacity, the moisture content, and irrigation requirements of the soil.

SUMMARY.

This Bulletin reports the results of a green manure experiment over a period of thirteen years with citrus trees at the Commonwealth Research Station, Griffith, New South Wales.

The growth of a winter green manure crop (tick beans) increased the growth and yield of trees compared with trees kept clean-cultivated.

The growth of a summer green manure crop (cowpeas) at first decreased the growth and yield of the trees owing to the competition of the cowpeas for soil moisture during the summer. After about ten years the trees on the cowpeas plots caught up to those on the clean-cultivated plots. The better growth of the trees in the cowpeas plots compared with those of the clean-cultivated plots, in later years, is due to the decline in fertility and loss of structure of the soil of the clean-cultivated plots, combined with the fact that the cowpeas do not offer such strong competition to mature trees as to young trees.

The growth of lucerne offers very strong competition to trees, and the growth and yield of trees on the lucerne plots are greatly reduced.

A marked seasonal cycle of soil nitrate concentration occurs on both the tick bean plots and clean-cultivated plots, the seasonal cycle being significant to 120 cm. deep in the tick bean plots but disappearing after 60 cm. in the clean-cultivated plots.

Rains and irrigation cause minor fluctuations in concentration of soil nitrate. The tick bean plots contain a higher annual mean nitrate content in the surface soil than the clean-cultivated plots; but the reverse is true at the lower depths. Throughout the whole profile to 120 cm. depth, the clean-cultivated plots have the highest nitrate content.

When tick beans are ploughed in before September, little decomposition takes place and nitrates do not increase until the beginning of this month. Early September seems the best time to plough under the tick beans.

The presence or absence of the citrus trees has little effect on the seasonal soil nitrate concentration cycle.

When tick beans are ploughed under, there is a rapid formation of ammonia in the surface mulch, and this persists throughout the early summer.

On the irrigated soils of the Murrumbidgee Irrigation Areas, concentrations of nitrates to the order of 10 to 20 p.p.m. are commonly found down to 100 cm. or more.

During growth, the green manure depresses the water table.

The increase in the water-holding capacity of the soil after several years' green manuring is statistically significant but practically unimportant. The green manure has, however, a marked effect in preventing or reducing the loss of structure of the soil that is noted in the clean-cultivated plots.

The relation of green manuring to the fertility of the soil is discussed.

[*Extract from Bulletin No.* 120 *of the Council for Scientific and Industrial Research.*]

THE COMPOSITION OF CAPEWEED (Cryptostemma calendulaceum) FROM MECKERING AND BEVERLEY.

A. B. BECK[1] and R. G. LAPSLEY.[2]

During the investigations of toxic paralysis carried out over the past three years, it has been noticed that with sheep, the occurrence of depraved appetite, and hence of toxic paralysis, is definitely associated with a low plane of nutrition due to the poor quality of the summer grazing. At Meckering, where the toxic paralysis investigations were carried out, the main plants of unimproved pastures are capeweed, silver grass and cluster clover. The analysis of the capeweed samples was undertaken to see if there was any abnormality in the chemical composition which might be correlated with the development of depraved appetite. For the purpose of comparison, plants were also analysed from the Avondale Research Station, Beverley, an area of heavier soils and better pastures, where depraved appetite is unknown. The work was also undertaken as a part of a wider investigation. Owing to the short growing season in the wheat belt areas, the natural pastures consist entirely of early maturing annuals. The quality of these pastures is of the greatest importance, in that the dry feed which the sheep receive in the summer is usually composed entirely of the dry residues of annual plants which have grown during the winter and spring. As a continuation of the pasture investigations commenced between 1933 and 1935 (Underwood, Shier, and Harvey, this Journal, December, 1937, page 442), it is the intention of the Animal Nutrition Branch to carry out a "long range" investigation of the subject in order to provide a basis on which to improve our pastures, and so to improve the nutrition of our sheep.

Samples were taken at intervals of from three to four weeks so as to ascertain the changes in composition during the growing season.

The samples from Meckering were obtained from a large paddock of about 100 acres in the Research Station property; half of this paddock had been cleared and cropped in past years. In the cleared area, from which all the samples were taken, there were two distinct soil types, a red sandy loam which comprised the larger part of the area, and also a small area of 4-5 acres of deep, grey sand. Normally when sheep were running in this paddock they had access to both areas. The capeweed was the main plant in the sand area, and was more sparse, although larger, on the loam. Except where specified to the contrary in the following tables, the sample analysed was a composite sample taken from both areas.

At Beverley two series of samples were taken. The first was from around an oat crop on typical York gum soil; this, as is usual, formed a large succulent growth and probably represents the best type obtainable. The second series was obtained from a paddock under grazing. This paddock was of a more sandy type of soil than that of the oat crop, and because of this and the grazing the plants kept quite small.

The sample from Merredin was taken from the typical heavy salmon gum and gimlet soil at the Research Station.

Experimental Methods.

The collection, sampling and analysis of the samples presented many rather peculiar problems, and standard methods had to be more or less arbitrarily adapted for this work.

The sample for analysis was obtained by picking a large number of plants from the area concerned until a sample of one to two lbs. green weight was obtained. The plants were picked up at random places over the area and were selected as average samples from that particular place.

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Samples were obtained by cutting off whole plants with curved scissors just above the ground. In most cases capewood grows close to the ground and the dense felt of hairs on the back of the leaves collects and retains the sand from the soil with great tenacity. Sieving the dried plants does not remove this sand, so for all the samples prior to the commencement of flowering, the plants were washed to remove the sand. It is realised that this procedure is open to the objection that there will be a certain loss of cell sap by diffusion, but as the washing only takes a very short time, it was considered that the error from this cause would be very small and certainly very much less than the error caused by the presence of the sand.

After washing, the plants were allowed to air dry to as near as could be judged to their original condition and then weighed in order to give their original moisture percentage. The samples were then dried at 60-70° C. and then allowed to come to an "air-dry" condition for crushing and analysis.

The earlier samples were crushed in a small coffee mill, but later a Wiley mill was installed and this was then used. In some cases during the air-drying process after oven drying, the plants took up so much moisture that it was necessary to use dried samples for crushing. In both types of crushing there was a certain amount of segregation of the woolly fibres from the back of the leaf, but with the product from the Wiley mill this was small.

Standard methods of analysis were used. "Moisture" is the loss on drying at 100° C. overnight. Ashing was done at a dull red heat, and the portion insoluble in 1:1 hydrochloric acid was termed "insoluble ash" (see later). The "ether extract" was done on moisture-free samples using ethyl ether. The crude fibre was filtered on a No. 54 filter paper. The appearance of the "crude fibre" from the younger samples was quite remarkable, the fibre consisting of the hairs from the back of the leaves and appearing as a felt-like mass. Phosphorus was determined volumetrically and in some cases colorimetrically as well; the agreement was not always as close as might be desired.

As is seen in the following table the "insoluble ash" of some of the samples is quite high. A microscopic examination of the product suggested that it consisted entirely of coarse sand grains, and so it was decided to correct all the analytical figures for this sand, using the assumption that the "insoluble ash" was entirely adventitious sand. This assumption is open to two possible errors; firstly the "insoluble ash" may contain plant silica, this is considered unlikely as the appearance of this ash showed nothing but sand and further an analysis showed that the "soluble silica" of capeweed ash is very low (about 1 per cent. of the total ash). The high base content of the ash would further tend to give acid soluble silicates during ashing. The second objection is that the insoluble ash may represent a part only of the adventitious sand and clay, as the high alkali would tend to convert the finer portions of these into soluble silicates. This objection, however, is not considered to be serious and it is considered that the method of tabulation of results will probably give the truest picture of the composition of the plants. Another reason in favour of this method is that the presence of coarse sand in the lighter capeweed makes sampling very difficult and even if the sand content varies the corrected figure will be unaltered.

In the following tables the "moisture" figure is of the sample as collected from the field, corrected for "insoluble ash." The "insoluble ash" figure is for the sample actually analysed, calculated on a moisture-free basis. All other figures are for the "moisture-free assumed ash" basis. These have been calculated from the actual analytical figures (moisture-free) as follows:—

$$\text{" moisture-free assumed ash " figures} = \text{actual analytical " moisture-free " figures} \times \frac{100}{100 - \%\text{ " acid insol." ash actual dry basis.}}$$

As an example of the method of calculation, Sample No. 100 as analysed contained 13.3 per cent. moisture, 3.0 per cent. insoluble ash and 20.6 per cent. crude protein. Correcting these for moisture, the insoluble ash and protein then become 3.5 per cent. and 23.8 per cent. respectively. To correct the protein figure for the insoluble ash it is multiplied by $\frac{100}{100 - 3.5}$; the protein content on a "moisture free assumed ash" basis then becomes 24.7 per cent.

In all cases except where specified to the contrary the analyses refer to whole plants collected as previously described.

TABLE 1.
MECKERING.

Date.	Sample No.	Moisture.	Assumed Ash Dry-Basis Figures. Crude Protein.	Ether Extract.	Crude Fibre.	N.F.E.	Assumed Ash.	CaO.	P_2O_5.	Insol. Ash.	Remarks.
8-6-37	77	92·6	27·5	3·8	13·2	39·3	16·2	2 15	0·55	1·4	
2-7-37	89	93·3	30·2	4·9	13·9	32·1	18·9	1·75	0·98	2·2	Specially selected ; ungrazed ; best growth available.
28-7-37	97	89·7	17·2	4·4	13·0	49·2	15 3	1·87	0·70	0·2	
17-8-37	132	86 5	11·4	3·0	13·0	62·1	10 5	1 79	0·43	0·6	Sample from red loam area only.
17-8-37	133	86·9	11·5	3·3	14·5	59 8	10·9	1·42	0·36	1·3	Sample from grey sand area only.
31-8-37	140	82·1	7 9	2·4	12·7	68·1	8·9	1 58	0·48	3·6	Some flowers out ; many flowering heads.
13-9-37	142	84·2	8·0	3·7	14 4	65 6	8·3	1·65	0·65	2 9	In full flower ; bottom leaves drying off.
29-9-37	152	81·0	6·9	6·0	19·3	57·0	10 8	2·14	0 50	1 7	Leaves drying ; still in flower. No seed heads shed.
13-10-37	160	79·8	5·9	4·9	22 7	54·7	11 8	2·14	0 35	1 9	Flowering finished ; many seed heads, large proportion shed; bottom leaves dry.
3-11-37	169	10·0	6 2	5·4	25·2	57·8	5 4	2 34	0 32	6 6	All dry.
31-8-37	139	84·8	10 6	5 5	14 7	60 1	9·1	1·76	0 71	1·9	Flowers with about ½-in. stalk ; badly infested-red mite.
13-10-37	161	82·7	11·2	5·0	15 9	59 3	8 6	1·55	0·68	0 5	Flowers ; all small.
Nov., 1936	176	7 5	13·2	.	.	.	.	1·41	1·22		Seeds.
13-10-37	162	10 4	11·3	3·9			8·4	1·53	0·97	0 7	Seeds.

Other analysis—No 97 : K_2O 3·45 ; Na_2O 2·74 : MgO 0·59 per cent.

TABLE 2.
BEVERLEY OAT CROP SAMPLES.

Date.	Sample No.	Moisture.	Assumed Ash Dry-Basis Figures. Crude Protein.	Ether Extract.	Crude Fibre.	N.F.E.	Assumed Ash.	CaO.	P_2O_5.	Insol. Ash.	Remarks.
22-7-37	91	93·1	25·1	4·8	16·4	37·2	16·5	1·34	0·67	0·1	
13-8-37	100	92·7	24·7	4·0	14·6	42·5	14·2	1·63	0·71	3·5	Stalks cut off largest samples.
30-8-37	137	92·9	16·5	3·9	17·8	44·4	17·2	1·50	0·59	0·2	Contained a few flowers.
16-9-37	150	91·0	15·2	5·7	16·7	48·2	14·2	1·69	0·48	0·4	A few flowers in sample.
6-10-37	156	89·7	10·2	7·2	19·0	46·9	16·7	2·21	0·38	0·2	In flower.
19-10-37	165	87·4	10·0	3·5	20·6	50·3	15·6	2·00	0·35	1·2	A few flowers, but mostly seed heads with seeds ; bottom leaves showing slight signs of drying off.
8-11-37	174	36·7	5·6	5·3	27·9	47·2	14·0	2·11	0·55	5·3	Stems moist, leaves dry.
23-11-37	177	7·2	6·5	3·8	27·0	50·0	12·7	2·70	0·31	1·7	Plants quite dry.
16-9-37	149	86·6	26·8	3·6	16·4	44·7	8·5	1·37	0·74	0·2	Flowering heads and about 2in. stalk only.
19-10-37	164	8·8	11·1	....	....	....	6·8	1·74	0·91	0·1	Seeds only.

Other analyses—No. 137 : MgO 0·60 per cent.
No. 100 : Na_2O 3·50 per cent. ; K_2O 4·86 per cent.

TABLE 3.

BEVERLEY STUBBLE PADDOCK SAMPLES.

Date.	Sample No.	Moisture.	Assumed Ash Dry-Basis Figures.							Insol Ash.	Remarks.
			Crude Protein	Ether Extract.	Crude Fibre.	N.F.E.	Assumed Ash.	CaO.	P_2O_5.		
21–5–37	76	93·1	26·0	4·3	14 4	37·7	17·6	1·85	0·88	9·6	
24–6–37	86	92·5	27·0	4·7	14·8	36·7	16·8	2 50	0·73	4·1	
22–7–37	96	88·8	17·0	4·2	15·8	49·7	13·3	2 22	0·55	3·1	Showing slight signs of grazing.
13–8–37	99	86 8	12 2	3 3	11·2	58·1	15·2	2·15	0·60	0 5	Not grazed recently; flower heads showing.
30–8–37	138	85·7	9·5	3·4	15·0	62·1	10·0	1 90	0·50	3 7	Some plants showing signs of grazing.
16–9–37	151	86·8	9 4	3·5	16·4	62·2	8·5	2 14	0·55	3·7	Plants all flowering.
6–10–37	157	86·9	10·3	4·9	18·4	55·5	10 9	2·16	0·47	1 3	
19–10–37	163	70 2	6·2	3·5	21 2	58·4	10·7	2 71	0·42	11·5	Most seed heads empty; bottom leaves dry.
8–11–37	175	24·0	5·7	4·5	23·5	56·9	9·4	2·40	0 45	9·4	Apparently all dry.

Other analyses.—No. 99: K_2O 2 18 per cent; Na_2O 1 72 per cent.

MERREDIN SAMPLE.—No. 135, 27–8–37: Moisture 90·4 per cent. Crude Protein 19 8, Ether Extract 3·1, Crude Fibre 12 2, N.F.E 50·5, Assumed Ash 14 4, Insoluble Ash 1 1, CaO 1·88, P_2O_5 0·64, MgO 0·66 per cent.

Discussion of Results.

The analyses of the Meckering plants show no abormality which would account for the development of depraved appetite in this area.

The most prominent feature of the analyses is the very high water content of the plants, which persists up to the time of flowering. This high moisture content probably explains the scouring and also the loss of weight that the sheep undergo when on the first green feed at Meckering. If the pasture were pure capeweed containing 92 per cent. water it would be necessary for a sheep to eat 25 lbs. green weight to obtain a dry matter intake of 2 lbs. The sheep apparently leave the dry grazing once the green feed appears and the sparseness of the growth of the early green feed makes the loss of weight easily understood.

If, however, we consider the dry matter only it is obvious that for the greater part of the season capeweed is a high quality feed. The high protein content in the early growth is quite outstanding and, even in the dry plants after the seeds have been shed, the percentage of protein is as high or even higher than that of average wheaten chaff. Up to the time of drying off the fibre content is relatively low and even in the most fibrous sample (No. 169) can hardly be regarded as excessive.

The assumed ash forms a high percentage of the dry matter. It should be remembered that, in the samples analysed the bulk of the adhering sand has been removed, whereas in the case of the material eaten by the animal the product will usually contain a relatively high percentage of sand. The percentage of sand is greatest in the young growth, particularly after rain.

The high percentage of calcium, sodium, and potassium contribute further evidence against any suggestion that depraved appetite in sheep might be due to acidosis caused by alkali deficient foods. The calcium content is high and the increase of calcium content in the older samples is worthy of notice. In most samples the phosphorus content tends to be on the low side as judged by overseas standards.

It is hoped at a later date to do a feeding trial with some sheep using dry capeweed alone and thus to obtain further data on the feeding value. In many parts of the Western Australian wheat belt capeweed is apparently regarded as a valuable fodder. The rapid early growth makes it valuable as a first green feed even although it causes scouring. It is regarded as a fair to good feed during growth, but not fattening until it has dried off somewhat. These observations are strongly supported by the analytical data which indicate that the high moisture content give it

a low feeding value in the green state, but on a dry basis it should be regarded as a fairly high quality feed.

As a contrast to Western Australian experience it is interesting to note that in South Australia capeweed is generally regarded as being unpalatable to sheep.

It is probable that the main advantage of capeweed as a pasture plant lies in the fact that it can flourish under conditions which prohibit the growth of better quality pasture plants. Although it has many advantages as a pasture plant, particularly for lighter soil areas, it also has several distinct disadvantages.

There is no evidence that the felt-like hairs or fibres on the back of the leaves cause any digestive troubles, but in some localities the internal fibres of the leaf and stem get between, and loosen the teeth of the sheep. The very succulent nature of the growth results in a low yield of dry matter per acre and the bulkiness of the plants enables it to crowd out more desirable species. When dry the capeweed tends to break up and blows away easily. Another important disadvantage has been suggested by the observations of Mr. K. R. Norris (private communication) which support the contention that capeweed favours the increase of Earth Mite (*Halotydeus destructor*, commonly known as red mite).

Although capeweed forms the bulk of the grazing on the lighter soils of the wheat belt and the analyses show that, on a dry basis, it is of good quality, yet, taking all facts into consideration it cannot be regarded as a good pasture species. Pasture improvement, including the introduction of legumes such as early subterranean clover, should do much to improve the present low-producing capeweed pastures in the better rainfall areas of the wheat belt.

AGRICULTURAL PROBLEMS.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

Albany	**H. R. Powell (Fruit); B. Williams (Dairying).**
Bridgetown	**A. Flintoff (Fruit); A. M. Tindale (Dairying).**
Bunbury	**M. Cullity.**
Geraldton	**N. Davenport (Government Buildings).**
Gosnells	**R. C. Owen.**
Harvey	**R. L. Cailes (Fruit).**
Katanning	**A. S. Wild.**
Kalamunda-Roleystone	**W. H. Read, c/o. Department of Agriculture, Perth.**
Kununoppin	**W. M. Nunn.**
Manjimup	**C. M. Scott.**
Metropolitan, Gingin, Chittering ...	**S. E. Bennett, c/o. Department of Agriculture, Perth.**
Mundaring	**V. Cahill.**
Narrogin	**A. T. Gulvin.**
Vasse	**J. M. Nelson.**

DIPPING OF FLOCKS.

By HUGH McCALLUM,
Sheep and Wool Inspector.

The only satisfactory method for eradicating ticks and lice is by dipping. This is an essential routine practice and must be carried out to obtain maximum value for the clip.

Tick and lice are blood sucking insects and the amount of damage done depends on the extent of infestation. They cause intense irritation which the sheep attempt to allay by rubbing on fences and logs and biting at the seat of irritation. The natural consequence is that the sheep are unsettled, go off their feed and lose condition. The damage is most apparent in the wool and patches of skin may even be denuded; therefore, besides actual loss of wool, there is also a lowering of the wool's value.

The following rules should be noted by the farmer:—

(1) Do not dip in extremely hot or cold weather.
(2) Do not dip thirsty, hot or overfed sheep. The sheep should be cooled off and completely rested before dipping.
(3) Commence dipping early and finish at least two hours before sundown to allow the sheep to dry off.
(4) Every animal should be completely immersed once.

All farmers should be aware of the regulations concerning sheep dipping in this State.

Information on sheep dipping can be obtained from this Department free of charge.

ALL-AUSTRALIAN EXPORT BACONER AND PORKER CARCASE COMPETITIONS.

The above competitions will be continued during next year when judging will be held in London in June. Entries for this series will be due at Australian works on 15th April, 1939.

The competitions were started mainly to provide a means of acquainting Australian pig raisers with the requirements as to type and conformation of the United Kingdom market, the only overseas outlet for our surplus pork. Australia's share of that market has increased steadily over recent years and to enable us to continue to compete it is essential that the requirements of United Kingdom consumers should be met. Prices are at present very good for the Australian supplier and, as supplies are regulated, are likely to remain so.

Carcases entered for the competitions are judged in London according to a system of measurements and photographs devised by Dr. John Hammond and other English authorities. Marks are awarded for various features such as body length, leg length, hams, shoulders, etc., and a full list of these marks is supplied to each entrant to enable him to see how far and in what respects his pigs fall short of the ideal.

Apart from the prospects of success in winning a prize—a sum of £25 is distributed in prizes in each section—the competitions thus offer a valuable service to all entrants.

Entry forms may be obtained from works which treat pigs for export, from the Departments of Agriculture and the Veterinary Officers of the Commonwealth Department of Commerce in each State and from the office of the Australian Meat Board at 401 Collins Street, Melbourne.

ELECTRICAL STERILISING OVENS.

Description of an Instrument Suitable for Dairy Bacteriology Laboratories.

By H. H. Kretchmar, B.Sc., A.A.C.I., Dairy Bacteriologist.

From certain information which has been brought before the notice of the writer, it is understood that difficulty has been experienced in obtaining ovens suitable for sterilising certain portions of the equipment often used in the routine methods of some dairy bacteriology laboratories. In consequence, the following description of the method of design carried out by the writer is offered in the hopes of its being useful in this connection.

The apparatus in order to meet the requirements of the writer's laboratory, had to fill the following requirements:—

1. Produce an even heating over the whole of the internal space.
2. Attain its working temperature within a reasonable period of time.
3. Maintain the working temperature with a minimum of adjustment.
4. Produce but little rise of temperature in the laboratory when installed. (The summer temperature in Perth is comparatively high).
5. Have sufficient length to accommodate milk sampling tubes or "thiefs" of a maximum length of 30in.
6. Possess sufficient space for 4 dozen milk sampling tubes together with an equivalent number of 1 oz. sample bottles.
7. Accommodate the usual other bacteriological apparatus such as Petri dishes, pipettes, etc., on suitable shelves.

To meet the above requirements as regards space for accommodating the various apparatus, it was decided that the internal dimensions should be, length 33in., diameter 12in. Also, brackets to carry three perforated shelves, evenly spaced, were decided upon. A circular cross section was chosen for the shape of the chamber because of ease of fabrication, particularly as regards the disposition of the heating windings.

To provide adequate heat insulation a 3in. packing with slag wool, distributed evenly on all surfaces in order that even heating of the interior would be maintained, was deemed advisable.

In the design of the heating element two factors must be taken into consideration; the power consumption and the temperature at which the element is to work. By interpolation from the designs of standard commercial ovens manufactured for other purposes, the element was designed to dissipate 440 watts and this power expenditure has proved most suitable.

From this stage forward the design is governed by the voltage of the power supply. As an example, an oven designed and built for the dairy laboratory at the Muresk Agricultural College, where the power supply has a voltage of 220 volts, will be described. As the element must dissipate 440 watts and the power voltage is 220 volts, the current the windings must carry is 440/220 = 2 ampères. In order to limit the current to this figure the resistance of the winding must be 220/2 = 110 ohms.

The temperature at which the wire is to work next requires consideration. For sterilising purposes the oven is required to work at a temperature of 170° C. When the oven is running at this temperature and the wire is producing just sufficient heat to make good the loss of heat from the oven to the atmosphere, it should be obvious that, with the winding close to the internal shell of the oven and heavily heat insulated externally, it should have, ideally, a temperature of approximately 170° C.

CHARACTERISTICS OF NICHROME WIRE.

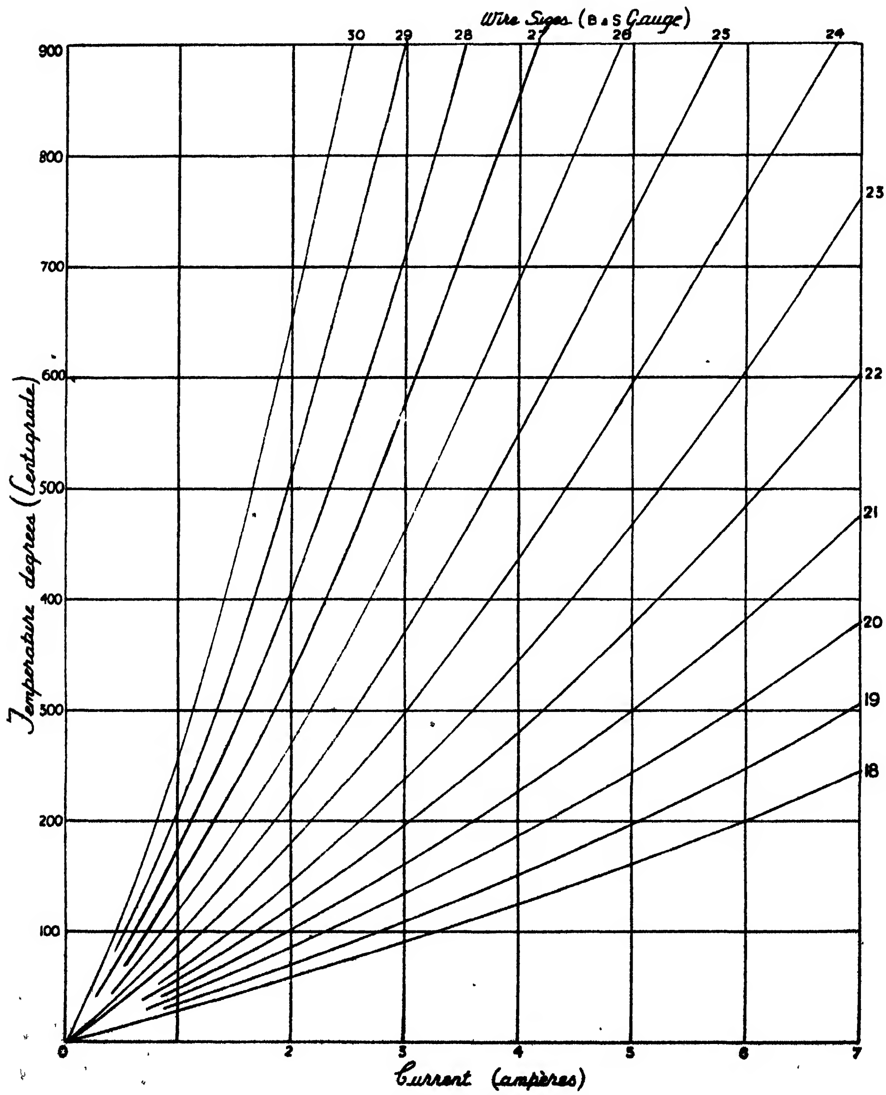
Gauge: B. and S.	Diameter: Inches.	Diameter: Mms.	Resistance per 1,000: Feet. Ohms.	Resistance per 1,000: Metres. Ohms.	Weight per 1,000: Feet. (lbs.)	Weight per 1,000: Metres. Kilos.	Stretched free: Ampères to give a temperature centigrade of: 100°.	200°.	300°.	400°.	500°.	600°.	700°.	800°.	900.°
18	·040	1·023	412	1,353	4·42	6·60	3·26	5·95	8·13	10·1	11·8	13·6	15·1	16·8	18·4
19	·(36	·911	509	1,669	3·58	5·20	2·76	5·04	6·88	8·60	10·1	11·55	12·8	14·2	15·6
20	·032	·810	645	2,115	2·83	4·23	2·32	4·27	5·83	7·30	8·53	9·70	10·85	12·0	13·2
21	·0285	·723	813	2,667	2·24	3·34	1·97	3 62	4·94	6·17	7·23	8·21	9·20	10·2	11·2
22	·0253	·643	1,031	3,382	1·77	2·64	1·67	3·07	4·18	5·23	6·13	6·96	7·80	8·65	9·46
23	·0226	·574	1,292	4,237	1·41	2·10	1 42	2·60	3·54	4·43	5·19	5·90	6·61	7·33	8·02
24	·0201	·510	1,634	5,360	1·12	1·67	1·20	2·20	3·00	3·75	4·40	5·00	5·60	6·20	6·80
25	·0179	·454	2,060	6,757	·89	1·33	1·02	1·86	2·54	3·18	3·73	4·25	4·67	5·27	5·76
26	·0159	·403	2,611	8,564	·70	1·02	·865	1·58	2·15	2·70	3·16	3·61	3·96	4·47	4·88
27	·0142	·360	3,274	10.739	·56	·84	·734	1·34	1·82	2·28	2·68	3·06	3·36	3·80	4·13
28	·0126	·320	4,159	13,641	·44	·65	·622	1·13	1·54	1·85	2·27	2·62	2·86	3·23	3·50
29	·0113	·287	5,168	16,951	·35	·52	·527	·960	1·305	1·57	1·93	2·22	2·45	2·71	2·97
30	·0100	·254	6,600	21,648	·276	·41	·447	·814	1·105	1·33	1·64	1·89	2·08	2·30	2·52
31	·0089	·226	8,333	27,332	·219	·326	·378	·680	·935	1·13	1·39	1·60	1·77	1·95	2·14
32	·0080	·203	10,313	33,826	·177	·263	·321	·577	·791	·955	1·18	1·36	1·50	1·66	1·81
33	·0071	·180	13,098	42,961	·139	·207	·272	·490	·670	·809	1·00	1·15	1·28	1·41	1·53
34	·0063	·160	16,623	54,523	·110	·164	·231	·416	·567	·685	·849	·980	1·06	1·18	1·29
35	·0056	·142	21,019	68,942	·087	·130	·196	·353	·480	·580	·720	·830	·900	1·00	1·09
36	·0050	·127	26,400	86,592	·069	·103	·166	·300	·406	·491	·611	·704	·765	·850	·924

Comparison of resistance with change of temperature:—
20° C. = 1 Ohm; 100° C. = 1·0185 Ohm; 200° C. = 1·0417 Ohm; 300° C. = 1 0645 Ohm; 400° C. = 1·0828 Ohm; 500° C. = 1·0928 Ohm; 600° C. = 1·0960 Ohm; 700° C. = 1·1022 Ohm; 800° C. = 1·11221 Ohm; 900° C. = 1·1257 Ohm.

The tables published by the various manufacturers setting out the characteristics of the resistance wires they manufacture, give only the current required to maintain the wire at stipulated temperatures when the wire is straight, horizontal and free to radiate. However, the writer's experience has been, that for apparatus working at low temperatures, such as low temperature-ovens, the data contained in such tables may be satisfactorily utilised by assuming an increase of temperature of about 50 deg. C. over the temperature shown in the Table for the type of insulation described.

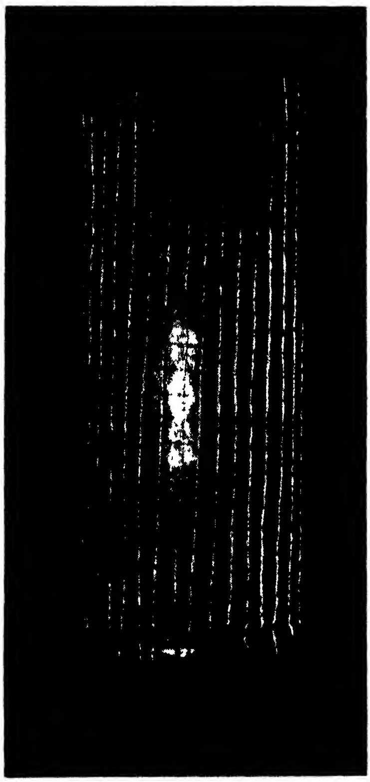
The wires used for heating purposes by the writer are made of the nickel-chromium alloy known as "nichrome" for which the characteristics of useful gauges are given in the Table.

A few of the temperature characteristics shown in the aforementioned Table have been shown graphically on the following chart in order that correlations may be made between other current values and temperatures.



To return to the problem under discussion, it is necessary to choose such a gauge of wire as will attain a temperature of approximately 170 deg. C. when carrying a current of 2 ampères. From the chart it may be seen that a suitable size of wire is 22 gauge, for when carrying 2 ampères and radiating freely the temperature attained is 120 deg. C. which, together with the assumed increase of 50 deg. C. when enclosed as discussed above, brings the working temperature to 170 deg. C.

The inner shell of the oven as finished is 36in. long by 12¼in. diameter. It is constructed of 20 gauge rolled sheet iron and has one end welded in place to form the back end of the oven. To strengthen the open end or front of the oven, a strengthening ring of steel is placed around it at 3 in. from the front end. Brackets, disposed as described above, are riveted inside and the completed shell tinned all over.

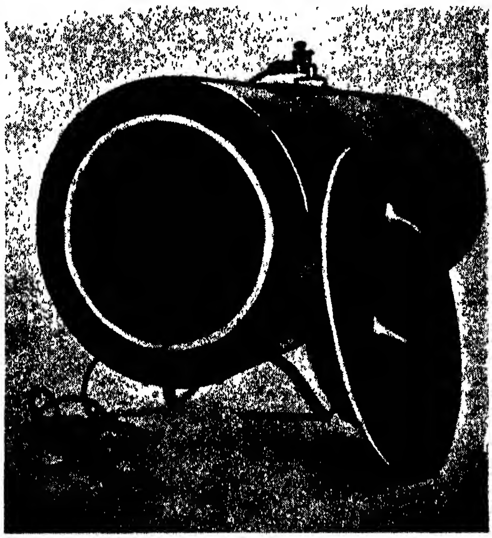


For the purpose of insulating the winding from the shell, the latter is covered with bonded mica insulating sheet ("micanite"), which is tied in place with string until the windings are in place. It might be thought that the use of such material for insulating purposes is risky because of the chance of breakdown of the bonding when subjected to the heat of the oven. However, no difficulty has been experienced from this cause.

To secure the ends of the winding, electrical two-line porcelain connecting blocks are utilised. A piece of strong wire is looped through two holes in the wall of the oven, the two ends of it passed through one of the metal junction tubes in the connecting block and fixed in place by the small grub screws. The end of

the winding to be secured is passed through the metal junction tube not utilised for fixing purposes, and held securely by the grub screws. In order that the leads to the winding may not foul the tubes used for accommodating thermometers, the porcelain blocks should be placed slightly to the side of the line running along the top of the oven. Three of these blocks are required, two fixed at positions 3 in. in from the front edge of the inner shell and the other fixed close to the back edge.

Some device must be provided to avoid the turns of the winding short-circuiting when they become loosened by the heating current. The writer uses a number of lengths of asbestos cord bound to each end of the inner shell by a turn of strong wire. They are fixed to the back end of the shell before starting the winding, inter-twined with the winding as the latter is put into place, and finally bound with another turn of strong wire at a distance of three inches from the front end of the shell, at which position the winding ends. The lengths of cord are so arranged that each length passes over one turn of wire and under the next and the various lengths pass alternately under and over the same turn of wire. Illustration on previous page shows a shell with winding in position.



The winding is put on in two equal lengths, the turns of one length between the turns of the other length. Both windings end at the one binding block at the back of the oven, but at separate blocks at the front of the oven. Adequate lengths of wire must be left attached to the ends of the windings for making connection to a series-parallel switch mounted on a piece of insulating fibre at a position half way along the top line of the outer shell. To insulate the connecting leads they may be passed through a number of 6 in. lengths of small bore glass tube. To compensate for the extra radiating surface at the end of the oven the turns may be placed a little closer together at these positions.

The outer shell of the oven is also made from 20 gauge sheet iron. The length is 39in.; the diameter 17½in. For strengthening purposes, two channels are rolled into it at positions 9in. and 30in. from the front. Two sets of legs, the shape of which may be seen in the illustration above, constructed of 1in. x ¼in. rolled steel, are riveted positions 7in. from the front and back ends. It is tinned all over.

The inner shell is held co-axially in the outer shell by an annular ring which has both edges flanged. The surface of the ring is tinned. The outer flange fits

tightly over the edge of the outer shell to which it is bolted by ¼in. bolts and nuts. For ease in fixing, the nuts should be soldered over the bolt holes and on the inner surface of the outer shell. The diameter of the hole in the ring being 13in., an annular space ⅜in. wide is left between the inner flange and the inner shell of the oven. This space is packed with sheet asbestos, forced into place, so that the only metallic connections between the inner shell and outer shell are the bolts used for fixing purposes. Eight quarter-inch countersunk-head nuts and bolts are used with the head of the bolt countersunk into the inner shell of the oven so that a free opening is left for the entry of the door.

The best procedure to adopt when assembling the oven is to bolt the annular ring to the inner shell (complete with its windings) as it stands on its back end, and then insert the inner shell into the outer shell as the latter stands on its back end. The two shells may then be fixed permanently together by bolting the annular ring to the outer shell. Nuts and bolts ¼in. diameter are used for the purpose. The oven is next placed on its front end, the insulating glass sleeves passed over the electrical leads, and the latter taken through holes in the top of the outer shell to the three-heat (series-parallel) switch. The fitting for making connection to the supply circuit is mounted alongside the switch. The fibre baseboard is conveniently fixed to the top of the oven by bolts screwed into thick nuts soldered to the upper surface of the oven. The tubes to accommodate the thermometers are placed in position in holes which have previously been made at points spaced evenly along the top of the oven. The slag wool packing is carefully tamped into position so as not to displace any windings or connections. When the packing is all in place the back end, which has been tinned and has a flanged edge, is bolted in place. As with the front annular spacing ring, the bolting down is facilitated by first soldering the nuts in place over the bolt holes on the inside of the shell. Eight nuts and bolts are required.

The lid is constructed in two parts. One part, which forms the outside of the lid, consists of a tinned iron disc 12¼in. diameter with a flanged edge ½in. deep. The disc holds two asbestos discs of ¼in. thickness. The other part of the lid, which in use slides into the oven, consists of a shallow tinned pan 12¼in. diameter, 3in. deep, with a flanged edge. It is packed with slag wool and bolted concentrically to the front face of the door on top of the asbestos sheets. This construction avoids metallic contacts other than the shanks of the bolts, between the inner part of the lid and the outer cover.

The reason for finishing the electrical winding three inches from the front of the inner shell will now be obvious. The first three inches of oven space are filled by the insulating portion of the lid.

The appearance of the oven is greatly improved by a coating of hard-drying black enamel.

During the initial heating process the switch is turned to the position marked "high." The two halves of the winding are then running in parallel so that the power consumed is 8 ampères at 220 volts, i.e., 1760 watts. The time required for the empty oven to reach a temperature of 170° C. in these circumstances is 30 minutes.

When the running temperature of 170° C. has been attained the switch is turned to the position marked "low." In this position the temperature of the oven remains constant or rises very slowly, the variation depending upon the room temperature. In any case turning off the current for a few minutes, say when the temperature reaches 180° C. (which occurs only two or three times during the sterilising process) causes such little trouble that the provision of a thermoregulator is hardly warranted.

SOIL SALINITY IN WESTERN AUSTRALIA.

Preliminary Investigations Into the Movement of Salt in the Red Brown Earth Zone Under a 15 to 25 inch Annual Rainfall.

L. J. H. TEAKLE.

The problem of soil salinity in the wetter portions of the agricultural areas of Western Australia has been apparent during the last 40 years. Manifestations are particularly noticeable in the Great Southern Districts but extend north to the Geraldton district and are even observed in the high rainfall coastal areas. Perhaps the most obvious occurrences are in the 15 to 25 inch rainfall belt or red brown earth zone, although in the light rainfall areas saline soils occur and may affect crop yields. The movement of soluble salts in soils in the light rainfall areas has already been discussed by Teakle and Burvill (1938) and will not be examined further here. In this paper the discussion is confined to the 15 to 25 inch rainfall belt.

Everybody acquainted with these areas is familiar with the glistening, crusty, bare patches and flats along many creeks and valleys. Also, salinity of dams and wells has further focussed attention on the problem not only from the agricultural point of view but also from the point of view of railway engineers.

Farmers early explained the "rise" of salt as due to the wholesale destruction of timber along the creeks and many advise leaving strips to "keep down" the salt. The fallacy of this diagnosis was rendered obvious by the death of timber left along many creeks for this purpose and a number of early writers pointed to a more sound explanation of the phenomenon. O'Brien (1917) writing in 1912 stated that, following clearing "natural vegetation no longer utilises the larger proportion of the rainfall, which entering the ground dissolves more or less of the salts, and as it soaks through the soil and gradually flows down the hillside to the lower land, the water carries the salts with it. In the summer time heavy evaporation takes place from these lower lands, the salt being left behind. After a few years this naturally results in large increases of salt in the hollows, and they are known as salt pans, samphire flats, or salt lakes." Paterson (1917) reported evidence purporting to substantiate this explanation and expressed the opinion that "after clearing, the whole tendency of salt is to leave the higher ground." Wood (1924) has presented further evidence and discussion supporting this explanation. He points out that generally the salinity of ground waters increases with depth and the removal of timber so increases percolation that the lower and more saline waters are driven into the valleys and lead to the development of soil salinity. Analyses reported show that within a few years of clearing catchment areas waters entering dams increase materially in salinity. For instance, at Cranbrook, waters which originally carried about 7 grains of salt * per gallon † increased following cultivation of the catchment areas to 73 grains per gallon. Likewise, "rivers" and intermittent streams have increased in salinity following agricultural development of the drainage areas. Thus, the Blackwood River water at Bridgetown apparently contained about 11 grains per gallon of salt in 1904. Between 1910 and 1917 in the course of 24 periodic examinations it has only once dropped below 20 gr. per gallon and three times has equalled or exceeded 100 gr. per gallon. The Murray River which drains a similar belt of country to the north (Hotham Valley) has

* Throughout this paper "salt" is reported as NaCl calculated from chlorides in solution.

† One grain per gallon is equivalent to 14.3 parts per million.

shown a similar increase of salinity. This river is particularly saline after the first winter rains which flush out the accumulations of the preceding summer. The maximum salinity reached in 1937 was 141 grains of salt per gallon at the sampling on May 25th and, in 1938, 170 grains of salt per gallon on August 1st. During the summer months the salinity appears to range between 20 and 50 grains per gallon. (Figures by courtesy of the Hydraulic Engineer, Public Works Department.)

Wood (1924) concluded that this salt is of "cyclic" origin, that is, is blown in from the sea and deposited on the ground as a dust or in the rainfall. Teakle (1937) has supported this with data from various sources.

General features of the red brown earth zone.

The 15 to 25 inch or red brown earth zone of Western Australia is typically of hilly topography and is drained by numerous creeks. The soils generally are sandy to loamy in texture at the surface with a clayey subsoil. At varying depths —from a few inches to many feet—decomposing rock occurs and it is in the deeper, clayey layers that the "cyclic" salt accumulates under virgin conditions. The rainfall is of winter incidence and 10 to 20 inches will generally fall in the months May to October. This concentration of precipitation promotes leaching and the normal soils are typically of the moderately leached type in which calcium carbonate has been removed or washed to the deeper layers of the subsoil.

Rainfall records for representative centres are given in Table I.

TABLE 1.

Rainfall Records for representative centres of the red brown earth zone.
(C.S.I.R., Aust., Pamphlet 42, 1933.)

Centre.	No. of Years.	Average Rainfall in Points (100 points = 1 inch)												Total.
		Jan.	Feb.	Mar	Apl	May.	June	July	Aug.	Sep.	Oct	Nov.	Dec.	
Chapman	25	27	48	65	44	234	438	399	263	162	96	20	22	1,827
Watheroo	32	41	58	70	71	232	368	326	222	158	87	32	36	1,701
Northam	50	28	38	73	81	220	332	348	255	162	99	39	35	1,710
Katanning	39	37	57	95	118	235	296	308	244	194	156	68	62	1,870
Gnowangerup	25*	58	68	113	145	217	230	218	190	162	140	65	63	1,669

* Information from the Divisional Meteorologist, Weather Bureau, Perth, to 1937.

The surface layers are normally low in salt in the virgin state, but some concentration occurs in the deep subsoil (see appendix).

The problem.

In developing a farm, clearing is usually first undertaken on the more productive soil types. These typically occur in the valleys and on lower slopes and cultivation is carried on more or less independently of the minor topographic features. The first manifestation of enhanced water movement is on the surface where development of gutters in the valleys may occur in the course of two or three years or more. Later, moist patches, indicative of subsoil water movement, appear in these valleys and frequently salt accumulates as a surface crust, a residue the result of evaporation of water containing soluble salts. These salt patches may be limited to a few yards in extent or may extend over many acres in extreme cases. Such large patches may be observed along the north branch of the Mortlock River at Goomalling, also at Wagin and many other centres, and are well illustrated in map of Beegenup (Fig. 1). The cross hachure in this instance shows the occurrence

of salt in a strip about 10 chains wide in the valley of the creek. Side extensions are observed along tributary creeks and gutters and in the south-west corner of the map is to be seen a salt patch developing as a result of a saline spring on the slope, well above the level of the valley (see Table 4 for analysis of water sample 125 from site 20 at the upper end of this patch).

The manifestation of the salt problem is most common in the valleys and along creeks but also occurs on the slopes where seepage of water brings the salt to the surface. The first appearance is generally noted within a few years of clearing and salt accumulation reaches a maximum in 10 to 20 years. Thereafter improvement is commonly observed. In the lower rainfall portions of this zone, and where heavy textured soils limit underground water movement, marked appearance of salt patches may be postponed for 15 to 20 years after clearing, the maximum is reached much later and recovery will be much slower.

In such areas, dams in lowlying parts frequently become saline due to saline ground water entering the bottom as the water table rises, to saline streams entering the dam and also to the flushing of saline patches in the catchment area. The salt dam shown in the south-east part of the map (Fig. 1) was regularly used for stock purposes 40 years ago but became brackish about 1910. The water showed 5,700 grains of salt per gallon and 6,200 grains total water soluble salts per gallon in February, 1938. (Water sample 132, Table 4.) Likewise wells have become saline as on Mr. A. M. Stewart's farm, Wagin. The water from this well contained 1,690 grains of salt per gallon on 17th April, 1936.

In dealing with this soil salinity problem four questions may be asked:—

1. What is the course of manifestation under different circumstances?
2. What are the limits of extension?
3. What management methods should be adopted?
4. Will the situation improve or deteriorate?

Water Movements.

In order to understand the problem, it is first necessary to understand water movement in soils under the conditions prevailing.

While a certain amount of the soil water may arise from cooling magmas, that of importance has its origin in the rainfall and is known as meteoric or precipitation water. Only meteoric water will be considered.

The rainwater falling on the soil is lost in various ways.

1. Some runs off the surface.
2. The rest percolates into the soil and—
   (a) later evaporates from the surface,
   (b) is lost by the transpiration of the plants growing on the soil,
   (c) remains in the deeper subsoil or joins the ground water and escapes in the underground drainage system of the area.

Under virgin conditions in the red brown earth zone (15 to 25 inch rainfall) run-off is small and creeks flow for only short periods, percolation to the ground water is probably not of major importance but is sufficient to produce the characteristics of a moderately leached soil. Transpiration is undoubtedly the major avenue for water loss.

As the vegetation is selective in the absorption of salts from the soil most of the "cyclic" salt from the rainfall remains in the soil and is gradually leached to lower levels and accumulates in the lower ground waters. A balance will be established so that the outgo of salt will equal that coming in and, consequently, the salt concentration in the subsoil and the salinity of the ground water will be dependent on the proportion of water percolating and escaping in the underground

drainage. It would be expected that heavier soil types, which restrict water movement and favour loss by evaporation and transpiration, would contain a higher percentage of salt and associated ground waters would be more saline than where porous soils exist. The higher salinity of the heavier soils has been proved in the course of extensive soil surveys in 12 to 15 inch areas and farmers of the red brown earth zone have frequently observed brackish springs to be associated with the heavy soils formed from basic dykes.

When the land is cleared, or the timber otherwise destroyed, surface run-off if accelerated and is evidenced by soil erosion. Also percolation is greatly enhanced and much more water reaches the ground water annually. Small underground streams make their way toward the valleys and the water table rises generally but more particularly in the valleys. Within a few years permanent water commonly occurs in the major creeks and many small tributaries as a result of this enhanced underground water movement. Springs break out on slopes, seepage patches appear, the water rises in wells, and sometimes water invades the bottoms of dams.

Mr. A. Hardie of Narrogin and Mr. A. A. Toll of Highbury have observed that the greatest flow of such springs, apart from the temporary winter flush, on their properties is during February, March and April. It apparently takes several months for the seasonal underground flow to reach the springs. The intake beds for this water must therefore be some distance away, probably many chains, and local water, that is water falling in the immediate vicinity, is of scant importance in promoting the formation of seepage patches.

The Salt Problem.

In the course of discussing the movement of water in the soils of the red brown earth zone the accumulation of salt in the subsoil and ground waters resulting from the selective absorption by vegetation has been mentioned. It was explained that the concentration of salt will depend primarily on the ratio of outflow to total percolation and this is determined largely by the porosity of the soil and the nature of the vegetation. Heavy soils, in which percolation is restricted and which usually carry a heavy growth of timber, will essentially be higher in salt than light and porous soils but the difference will be quantitative and the accumulation will involve identical principles.

With enhanced water movement following clearing or destruction of the timber the equilibrium is upset and salt begins to move out of the soil with the water. Equilibrium under cultivation will involve a much lower salt concentration in the soil.

The underground drainage conditions are inadequate to remove the extra water and water tables rise. This is noticed particularly in the valleys where creeks may develop permanent pools and the ground water may affect dams. Unfortunately, this new flow of water is frequently brackish or somewhat saline due to the accelerated removal of the salt which has accumulated in the soil over the ages. And the salt concentration will be determined by such factors as the nature of the soil, the amount of percolating water, etc. Also, the rising ground water may be brackish or saline.

When this brackish or saline water comes within 3 or 4 feet of the surface, capillarity may be active enough to maintain surface evaporation of water and this leads to the surface accumulation of salts and consequent soil salinity, which may extend over considerable areas of erstwhile fertile soil.

Similarly, by evaporation, pools and dams affected by the rising water table may become exceedingly saline as the season advances. (See samples 132 and 137, Table 4.)

The Course of Manifestation.

The general course of manifestation of soil salinity in the red brown earth zone has been discussed above. Unfortunately, details are sadly lacking and organised enquiries are necessary to obtain information of considerable importance from the point of view of crop production and farm water supplies.

A few cases may be cited to indicate the type of evidence so far obtained. These probably represent conditions throughout the zone with some accuracy.

1. Mr. MURDOCK, BALLAYING.

(Examined April 16th, 1936; Locs. 2021, 4138.)

A salty valley 15 to 20 chains wide runs through the property and spread is apparently being retarded by a shallow drain cut through the lowest part. Before clearing 20 years previously the water table stood at 12 to 13 feet. Water under some pressure was encountered at 3 feet 6 inches on April 16th, 1936, and was found to contain 2,430 grains of salt per gallon. The total water soluble salt content was 2 650 grains per gallon.

2. Mr. A. M. STEWART, "Solai," WAGIN.

(Examined April 17th, 1936.)

A flat, which had originally carried york gum and jam timber and from which the land rises fairly abruptly, was cleared in 1911 and 3 good crops of cereal hay obtained. Evidences of salt appeared within 5 or 6 years and spread rapidly. Now some 200 acres of 500 are too badly affected to warrant cultivation and the remaining 300 acres are more or less affected.

A well on the edge of the flat near the stables is now salty and the water level was within 3 feet of the surface. The water contained 1,690 grains of salt per gallon. A number of mound springs were also observed on the flat. Water from one such spring contained 1,080 grains of salt per gallon and 1,280 grains of total water soluble salts per gallon.

3. Mr. AUSTIN PIESSE, WAGIN.

(Examined April 17th, 1936.)

A salt affected creek and small salt flats were observed, but the problem appeared of small magnitude. A spring in the bank of the creek yielded water containing 784 grains of salt and 987 grains of total water soluble salts per gallon.

4. Mr. S. C. DALL, QUAIRADING.

(Information supplied November 17th, 1938.)

At time of clearing in 1907 the salt water stood at 21 feet below the surface in salmon gum and gimlet flats. It is now within 14 feet of the surface. The rise is attributed partly .. drainage from the north-east along the salt channel through Hines Hill, Nungarin, Lake Brown, etc.

5. Mr. C. TAYLOR, "Beegenup," BROOME HILL.

(Examined February, 1938.)

A more exhaustive examination was made of Mr. Taylor's property to obtain reliable data concerning the manifestation of the problem. Unfortunately, Mr. Taylor had been in possession of the property only since September, 1928, and early history was not readily available. He estimated that about 90 acres were

salt affected in 1929 and some 150 acres in 1937. This alarming spread led him to seek advice with the result that an investigation was undertaken.

A general soil survey of the property was made to determine the nature of the soils and the incidence of salt carefully examined. Figure 1 represents the results

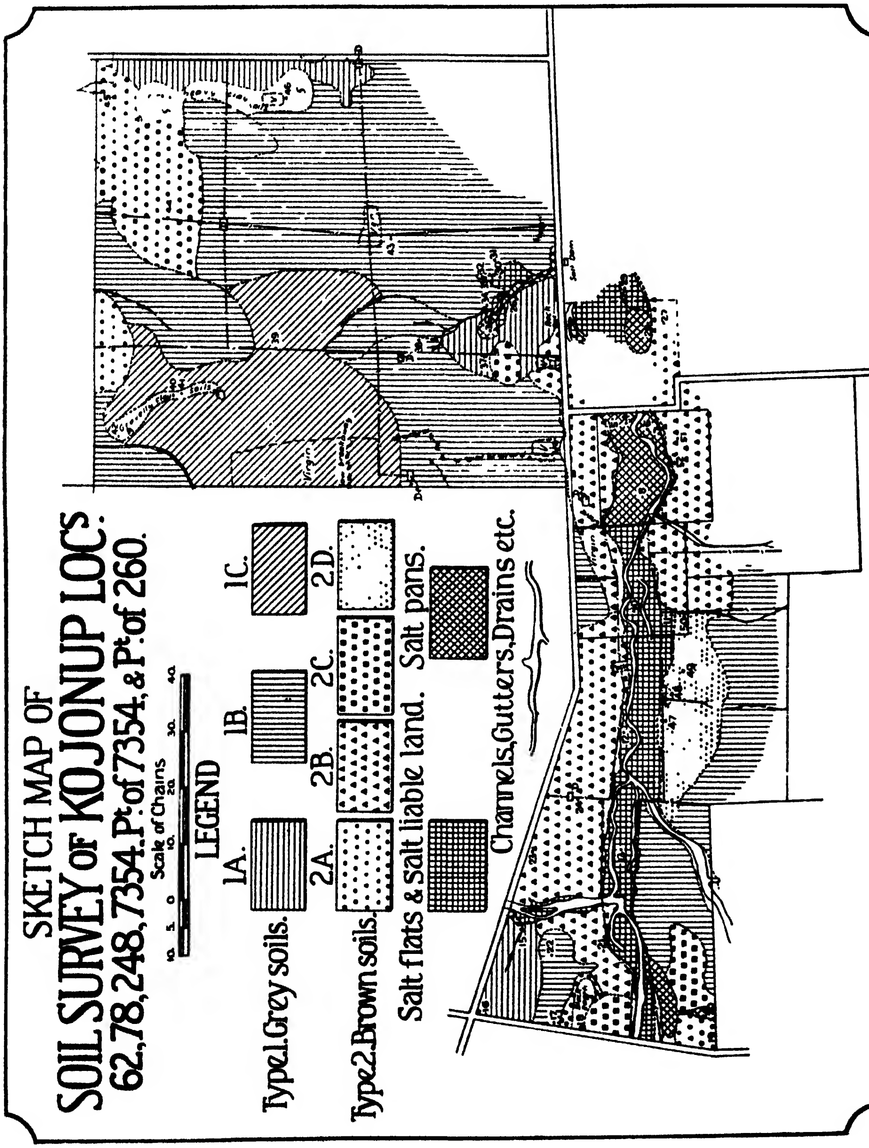


Fig. 1.—Sketch map of Beegenup Soil Survey.

of the soil survey and shows the occurrence of salt along the creek and tributaries, gutters, etc. through the property. The soil types are described in the Appendix, but pertinent details of the factors relating to the incidence of salt are recorded below. The location of sites sampled are shown by the numbers on the plan. (Figure 1).

The property is situated in hilly country and is drained by the Beegenup Creek and its tributaries. The creek valley averages about 10 chains wide and is generally uncleared except in the eastern 20 chains. It has been fenced off, partly on account of the salt incidence, and farming operations, involving the production of wheat and the raising of sheep, are confined to the slopes and higher land.

The slopes rising from the valley of the creek are quite marked and would generally be 3 to 5%. Steeper slopes occur in parts.

The chief timbers of the property were york gum (*Eucalyptus foecunda* var. *loxophleba*), morrel or poot (*E. longicornis*), wandoo (*E. redunca* var. *elata*), yate (*E. cornuta* or *occidentalis*), and jam (*Acacia acuminata*). Wandoo grows most typically on the more gritty, gravelly and sandy grey soils and yate in the wetter areas. York gum is more typical of the heavier textured brown soils of the valley. Morrel, york gum, wandoo and jam may form an association which is uncommon in more northern districts. Needlebush (*Hakea Preissii*) grows on the heaviest soils such as black earth and in the creeks. Mallees (*Eucalyptus annulata* and spp.) grow on patches of heavy, tenaceous clay soils.

The soils are representative of the red brown earth zone in many characteristics. (See appendix). In addition to the valley bottom soils two main groups occur: (a) the brown and brownish soils, generally on the lower slopes of the valleys (Types 2A, 2B, 2C and 2D) and (b) grey soils with more or less pipe clay in the subsoil and frequently showing admixture of ferruginous gravel (laterite). (Types 1A, 1B and 1C.) The brown soils appear to be forming on granitic rocks exposed by erosion and the grey soils on a much decomposed white rock horizon containing much quartz and kaolin and sometimes rounded pebbles.

Analyses of representative samples of these soils are summarised in the distribution table—Table 2. Details are given in the Appendix.

TABLE 2.

Distribution Table showing the Range of Salt Concentration in Profiles (a) from Normal Soils of Types 1 and 2, (b) from the Valley and Seepage Areas where Salt appears on the surface.

Range of Salt Concentration: per cent. NaCl.	Number of Samples in each Range									No. of Sites.
	Above 1 00	0 75–1 00.	0 50–0 75.	0 25–0 50.	0 15–0 25	0·10–0 15	0 05–0 10.	0·01–0 05.	Below 0 01.	
(a) Normal Soils of Types 1 and 2—Cleared and Cultivated country.										
0–12in. deep							3	12	6	21
12–24in. deep					1	1	7	8	4	21
24–48in. deep				1	1	4	8	4	1	19
Below 48in. deep					2	1	.			3
(b) Valley Soils, etc., where Salt appears on the surface										
0–12in. deep ...			5	2	3	3	2			15
12–24in. deep .		1	1	3	1	6	1	1		14
24–48in. deep			2	5	3	1	1	1		13
Below 48in. deep			2	7	1	1				11

Concentration of Salt in surface ½in. to 1in layer of valley types, etc., where Salt appears on the surface	7·52%, 4 86%, 6 83%, 4 2%, 1 96%, 5 75%, 0 77%, 0 64in %, 1 11%, 1·76%, 8 29%.

This information may be presented in the form of weighted averages for the various horizons. These averages may serve to emphasise the contrast between normal soils and the valley soils where salt is now apparent.

The comparison is as follows:—

Layer.	Normal country types 1 and 2.	Valley soils and soils from seepage patches where salt accumulation is apparent.
	per cent. salt*.	per cent. salt*.
0–12 inches	0·024	0·36
12–24 inches	0·052	0·26
24–48 inches	0·09	0·33
Below 48 inches	0·18	0·37

* Salt calculated as sodium chloride from chloride and expressed as per cent. in the oven dry soil.

The normal soils are quite low in salt but some concentration (0.18 per cent. salt) occurs in the deep strata (below 48 inches). It is most likely that some leaching has occurred as this land was cleared many years ago.

If it be assumed that the salt concentration of the normal soils of types 1 and 2 was originally similar to that of the valley soils before the rise of the water table, it is obvious that considerable accumulation has resulted from the movement of saline water. The most marked accumulation, of course, is in the upper layers, affected by surface evaporation of water. As shown in Table 2 the surface half to one inch layer may contain several per cent. salt and the above averages depict the considerable accumulation which has occurred in the layers to a depth of 48 inches. The usual salt concentration gradient of a soil profile, which is represented by the results quoted for normal soils, has been upset. Below 48 inches these valley soils are more saline than the normal soils but the difference is much smaller. Whether this is the result of water movement since clearing the country took place cannot be determined but it seems probable that the present difference is due at least partly to recent contact with saline water.

These observations lead to a consideration of the composition of the subsoil and percolating waters to which the development of this manifestation of soil salinity is ascribed. Some 29 samples on "Beegenup" and neighbouring farms were collected and analysed.

All waters examined were slightly alkaline in keeping with the reactions of the subsoils.

TABLE 3.

Distribution Table showing the Range of pH Values of Waters collected in the course of the Beegenup Survey.

——	Number of samples in each range.							No. of Samples.
Range pH ...	7·2–7·4.	7·4–7·6.	7·6–7·8.	7·8–8·0.	8·0–8·2.	8·2–8·4.	8·4–8·5.	
	2	3	6	4	3	12	2	32

The salinity (salt and total water soluble salts) is shown in Table 4 together with information concerning the salt content of the subsoil below the level of the water table.

TABLE 4.

Composition of Waters and Soils in Contact with this Water on Beegenup and neighbouring Farms.

Serial No.	T.W.S.S. gr./gal.	Salt (NaCl). gr./gal.	Salt (NaCl). per cent.	Salt Content of Soil in Contact with water. per cent.	Ratio— $100 \times \frac{\text{Salt in Soil}}{\text{Salt in water}}$	Average Texture Classes of Soil Horizons in Contact with Subsoil Water.	Depth of Water below Surface after standing 24 hours.	
(a) Along Mullidup Creek on Mrs. Stewart's Property, about 1 mile N.W. of Beegenup—							inches.	
106	70	52	·075	N. D.	...	...	60	Well 24ft. deep.
107	230	175	·25	N. D.	...	...	?	Well 13ft. deep.
108	525	475	·68	N. D.	...	...	36	Well 12ft. deep.
109	119	98	·14	N. D.	...	...	36	Well 15ft. deep.
111	720	660	·94	N. D.	...	...	...	Spring in bank of creek.
110	2,200	1,990	2·84	N. D.	...	...	6	Water in creek sands adjacent to spring.
(b) Samples along Beegenup Creek and Mullidup Creek—								
113	1,410	1,270	1·81	N. D.	...	...	22	Site 5 in salt pan.
114	1,440	1,270	1·81	N. D.	...	...	8	Site 4 in salt pan.
115	1,390	1,200	1·72	N. D.	...	...	1	Site 6 in salt pan.
116	1,390	1,260	1·80	N. D.	...	...	17	Site 7 in salt pan.
117	1,480	1,380	1·97	0·39	19·8	Sandy loam ...	32	Site 8 in salt pan.
118	1,560	1,420	2·03	0·36	17·7	Sandy loam ...	50	Site 9 in york gum flat.
119	1,530	1,380	1·97	0·41	20·8	Sandy loam ...	53	Site 10 in york gum flat.
122	2,230	2,040	2·92	...	...	...	45	Site 13 in york gum flat.
126	1,600	1,500	2·14	0·44*	20·6	Clay	32	Site 25 in cleared area
123	2,390	2,250	3·32	0·54*	16·8	Sandy loam ...	36	Site 14 in salt flat along Mullidup Creek
(c) Samples from Salty Patches on Slopes above the Creeks—								
120	1,410	1,250	1·78	0·26	14·6	Sandy loam ...	36	Site 11, top end of salt patch.
121	1,180	1,060	1·52	0·30	19·7	Sandy clay ...	44	Site 12, top end of salt patch.
125	1,620	1,520	2·17	0·45	20·7	Clay	18	Site 20, top end of salt patch.
127	1,510	1,410	2·02	0·46	22·8	Clay	18	Site 26, in salty tributary.
128	1,620	1,490	2·13	0·34	16·0	Sandy laom ...	34	Site 28, salt patch.

130	1,250	1,170	1·67	0·26*	15·6	Pipe clay ...	41	Site 30, salt patch.
131	1,230	1,140	1·63	0·21	12·9	Pipe clay ...	36	Site 36, top end of salt patch.
134	930	900	1·28	0·14	10·9	Clay	49	Site 48, top end of salt patch.
136	1,150	1,060	1·52	...	...	...	12in. above creek level	Site 52, salt spring flowing into creek.
(d) Samples from Slopes where no evidence of Salt appears—								
124	625	555	·79	0·18*	22·8	Pipe clay ...	71	Site 15.
129	560	460	·66	0·08	12·1	Sandy loam ...	69	Site 29.
133	1,250	1,130	1·61	0·21	13·0	Loamy sand ...	56	Site 47, good stubble.
135	840	780	1·12	0·18*	16·1	Pipe Clay ...	65	Site 50, grassy slope.
(e) Dams and Pools—								
112	35	35	·05	...	...	...	...	Nigalup dam unaffected by salt influences.
132	6,200	5,700	8·12	...	...	...	...	Salt dam opposite site 25; affected by rise of salt water table.
137	5,100	4,700	6·68	...	...	...	...	From pool in creek near site 52.

* Includes material above and below the water table.

The low ratio of salt in the soil to salt in the water is suggestive that the soil and the invading waters are not yet in equilibrium and that the salt water exists largely in channels and cavities in the soil mass. It has not yet displaced entirely or thoroughly mixed with the fresh capillary water originally present in the soil.

This deduction gives rise to a problem of considerable importance and which requires early investigation. The information given in Table 4 indicates that the salinity of the ground water along Beegenup and Mullidup creeks resembles that of streams encountered at salty patches on the slopes in the vicinity. It may be asked whether the ground water encountered in the creeks is merely a continuation of the streams seeping in from the slopes or represents the water table risen from a considerable depth during the period since clearing was commenced?

Waters of similar salinity have been encountered in many other parts of the zone and representative analyses are given in Table 5.

TABLE 5.

Salt Content of Subsoil Waters and Spring Waters in the Red Brown Earth Zone.

Serial.	District.	Source.	Depth of Water.	Salt content. Per cent.	Salt content. Grains per gallon.
			feet.		
1	Moulyinning	Subsoil	5	3·22	2,250
2	do.	do.	3	2·83	1,980
3	do.	do.	2½	1·09	763
4	do.	Sand soak	?	0·34	238
25	Wagin	Mound spring ...	...	1·55	1,080
29	do.	Well	3	2·42	1,690
30	Ballaying	Subsoil	3½	3·47	2,430

Summarising the discussion leading up to the answer to the first question proposed on page 436 it is stated that there can be little doubt that the development of soil salinity in the red brown earth zone is generally due to the accelerated movement, following clearing of the timber, of brackish and saline waters. This leads to the formation of a shallow water table in valleys and to seepage patches on slopes. When the water level is within 3 or 4 feet of the surface, a continual supply of moisture to the surface may be maintained. Evaporation of this moisture occurs, particularly in the summer months, and results in surface accumulation of soluble salts—and the manifestation of soil salinity.

Limits of Extension.

It has been shown that the development of soil salinity in the red brown earth zone is generally the result of water movement. Brackish or saline water seeps to lower levels and may raise the ground water to such an extent that capillary forces may bring salt to the surface. At the same time many creeks flow over much longer periods than before clearing took place and may contain more or less permanent pools of water. If the incoming water raises the water table above the level served by the bottom of the creek the excess water will be rapidly removed by a flow in the channel. Thus the level of the channel controls the height of the water table in the valley and limits the extension of the salt affected areas. It is improbable that soil salinity will develop in this zone if the water table is lower than 6 feet from the surface. There are no grounds for the fear that the salt will creep up the slopes and ruin large areas of good land.

The evidence of soil salinity on the slopes arises from saline underground streams reaching the surface, as a result of clay bars, rocks, etc., before they reach the valleys. The saline patches resulting cannot be expected to extend to large dimensions and are regarded as inconveniences rather than serious liabilities.

The answer to the second question proposed on page 436 is that, although salt encroachment is rapid for a period, extension is limited to valleys where a brackish or saline water table may reach within a few feet of the surface and to the vicinity of seepage patches forming on slopes. The problem may affect some farmers severely but does not jeopardise agriculture.

Management Methods.

Many people appear to believe that the salt in some way rises out of the valleys and encroaches on the higher land. In consequence, the leaving of green timber along creeks and valleys is advocated to "keep down the salt." From the foregoing discussion it is obvious that the salt does not owe its origin to the conditions in the valleys but to the seepage of waters from the higher country following the clearing of the area. If the higher country be cleared and can act as an intake bed for moisture, no amount of timber in the valleys can prevent the extra water from seeping in. The green timber may absorb a considerable proportion of this water and so retard the development of a shallow water table. In many cases, as at Beegenup, the saline ground water rises and the valley soils become saline both in the timbered and cleared areas. Furthermore, there are many instances of the timber dying as a result of the risen water table and soil salinity.

Therefore, as far as the development of soil salinity is concerned, the leaving of timbers in the valleys will be a minor factor in control measures and such manifestations must be accepted as a consequence of the development of the country.

From other points of view, such as the aesthetic value, the provision of shelter belts for stock, provision of some measure of control of wind erosion and economy in clearing costs, it is highly desirable to leave belts of timber along valleys and is strongly recommended.

Where saline patches occur in cultivated land, cultivation of the salty areas is desirable to promote water absorption and leaching, to limit surface evaporation and wind action and to facilitate the establishment of a vegetation cover of some agricultural value. Mr. S. C. Dall, of Quairading, finds that bare fallowing favours the extension of the saline bare patches, but autumn plowing coupled with wet seeding, after the first rains have washed the surface salt into the subsoil, brings about an appreciable establishment of crop on areas otherwise sterile.

There seems little evidence of deleterious effects from cultivating saline patches. The weight of evidence in answer to the third question proposed on page 436 favours cultivation to promote the washing down of the salt and to afford a better chance of crop establishment. Conservation of moisture over the summer period by bare fallow is undesirable. The objective is the establishment of a vegetation cover and special crops may be sown, fertiliser applied and farm management adapted to promote this end.

Future Development of Soil Salinity.

An understanding of the fundamental factors underlying the soil salinity problem in the red brown earth zone leads to an optimistic view of the future. There can be no doubt that accelerated drainage accompanies the rise of water tables and development of seepage patches and springs which result from enhanced water movement following clearing of the surrounding country. The incoming water is relatively pure, as rain water will average 1 to 2 grains of salt per gallon, and this water will gradually displace the more saline subsoil water. The first

results of the displacement process as shown by Burd and Martin (1923) will be the appearance of the saline subsoil water in the valleys and at seepage patches or springs. As displacement proceeds more or less imperfectly due to cracks and channels in the soil, dilution of the saline water will occur and the percolating water will become less and less saline. Eventually the whole of the saline water will be removed and subsoil waters, where drainage is possible, will become fresh or non-saline. This conclusion is of great importance to many agriculturists. Tangible evidence that this is happening is available and a few instances may be cited as representative:

Mr. Ashworth, of Yilliminning, has reported that two wells on his property which were saline 12 years ago are now fresh. A similar decrease in salinity has been observed in a well on the Chapman Research Station.

Mr. Cliff Anderson, of "Narrawong," 14 miles west of Katanning, in discussing the conditions on his property, stated that, after clearing the surrounding country in 1907, salinity developed in the water of a valley through the property to such an extent that it became unfit for stock. The salinity appeared to increase until 1930, but thereafter improvement commenced and by 1937 the water of the valley was quite "sweet" and suitable for stock purposes.

Mr. E. H. B. Lefroy, of Walebing, and Mr. Austin Piesse, of Wagin, report that saline patches are beginning to grass over after being bare for 10 to 20 years. Similiar observations have been made by the writer in the Northampton district.

Generally in the better rainfall areas, and where very heavy textured soils are not very prevalent in the lower rainfall portions of the zone, such improvement is noticed within 10 to 20 years of the appearance of the trouble. Where the heavier textured soils occur under a 15 to 17 inch rainfall the movement of water, and hence salt, is slower. The evidence of salinity takes longer to appear and it is certain that a good many years may elapse before improvement sets in. No estimate of this time factor can be made at present.

Certain action may be taken to assist nature in the removal of salt occurring under these circumstances. Flow in the creeks should be facilitated to accelerate drainage. Seepage patches occurring on slopes may be tapped by T drains. The top part of the T drain intercepts the percolating water and the stem removes it to the valley. Moisture absorbing plants of some salt tolerance may be established to utilise portion of the percolating water and provide feed for stock. Judicious cultivation and cropping will promote reclamation.

The answer to the fourth question proposed on page 436 is that salinity of soils and waters may increase rapidly for a period and will reach a peak. Continued displacement by the percolating rainwater will then bring about improvement and in the course of time the soils and underground waters will lose their salinity and become of agricultural value.

Summary and Conclusions.

Evidence has been presented to show that soil salinity develops in the red brown earth zone of Western Australia, under a 15 to 25 inches rainfall, largely as a result of enhanced movement of water following the clearing of the country. The "cyclic" salt which accumulated in the deeper layers of the subsoil and in the decomposing rock below under virgin conditions, is washed downwards with the increased water percolation following clearing. With the water, it reaches the valleys or springs and seepage patches, and surface accumulation of the salt occurs when the ground water is within a few feet of the surface. Analyses show that concentrations of waters in the vicinity of saline areas commonly range from 1,000 to 2,000 grains of salt per gallon and where surface evaporation of water occurs the surface inch of soil may contain several per cent. salt.

As the incoming rain water is relatively pure, containing only 1 to 2 grains of salt per gallon, continued displacement, if imperfect, leads to the removal of the salt and eventually the percolating water will become fresh. This fact is of great importance with respect to supplies of stock water and water for agricultural purposes. Concurrently, enhanced drainage will remove the salt from the soil and grasses will take possession of the erstwhile saline patches.

Where high rainfall and porous soils facilitate water movement through the soils improvement is noticed in 10 to 20 years but many years may elapse before evidence of reclamation is observed where heavy textured soils predominate and the rainfall is less generous.

Nature may be assisted in the reclamation of saline areas in this zone by facilitating drainage, establishment of a vegetation cover by appropriate cultivation and other means.

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APPENDIX.

Details of soil types recognised and mapped in the Beegenup soil survey—See Fig. 1.

The soils fall in Avon region of the red brown earth zone and exhibit the main features of soils of that zone—clay accumulation in the subsoil, alkaline reaction in the subsoil and occasional occurrence of calcium carbonate in the deeper subsoil. The colour factor is variable as the range is from red brown to light grey. The brown soil types generally form on material from rocks of the granitic or gneissic type and the grey soils from a kaolinised horizon, apparently a metamorphosed sediment which has not been identified geologically. An interesting occurrence of black earth was discovered on a basic dyke. Laterite capping and laterite gravel are common, particularly on the higher levels and are associated with certain of the grey soil types. Small areas of other soil types were recognised. With the exception of certain valley soils all samples were from cleared and cultivated areas.

A. Grey soil types.

—associated with kaolinised rocks.

3 types of grey soils were recognised and mapped.

TYPE 1A.

0 to 9 or 12ins.: grey loamy sand to sandy loam more or less gritty.

9 or 12ins. to 4ft.: yellowish to greyish gritty clay—more or less soapy feel.

Below about 4ft.: pipe clay.

Timbers: wandoo, morrel, york gum.

TABLE A.

Salt Content and Reaction of Soils of Type 1A.

Site.	Depth.	Salt (NaCl). %	pH.	Site.	Depth.	Salt (NaCl). %	pH.
	ins.				ins.		
15	0–10	·05	7·14	16	0– 9	·01	6·52
	10–26	·07	8·44		9–24	·05	8·96
	26–32	·07	8·56		24–36	·11	8·86
	32–50	·06	8·30		36–	·14	7·42
	54–79	·18	8·45				
				37	0–10	·01	6·49
					10–24	·02	7·47
					24–40	·03	8·08

TYPE 1B.

0 to 4 or 6ins.: light grey gritty loamy sand to sandy loam.

4 or 6ins. to 2ft.: light brownish grey with orange mottlings gritty sandy clay loam.

Below about 2ft.: white and yellowish pipe clay.

Timber: wandoo.

This type appears to be somewhat acidic in some instances. Influence of laterite may in some measure account for this and therefore these sites show an affinity for type 1C.

TABLE B.

Salt Content and Reaction of Soils of Type 1B.

Site.	Depth.	Salt (NaCl).	pH.	Site.	Depth.	Salt (NaCl).	pH.
	ins.	%			ins.	%	
17	0– 4	·02	6·78	31	0–15	Trace	6·54
	4–28	·03	8·26		15–27	·01	6·90
	28–38	·09	8·13	38	0– 8	·02	6·96
22	0– 3	·03	6·62		8–20	·03	8·04
	3–20	·04	8·22		20–36	·06	8·22
	20–	·13	8·14		36–45	·06	7·98
34	0–12	·05	6·47	43	0– 5	·01	4·97
	12–21	·16	6·14		5–17	·02	5·51
	21–41	·34	5·12		17–32	·03	5·38
					32–40	·06	6·15

TYPE 1C.

0 to 18in.: dark grey to yellow brownish grey sand with quartz, grit and ironstone gravel.

18 to 25in.: yellowish grey brown very gravelly sand.

25in. to 3ft.: yellow brown and red gravelly cementy sandy clay loam. pipe clay occurs below this horizon.

The soil is very low in soluble salts and slightly acidic to neutral in reaction. The lateritic material has probably affected the properties to an important extent.

TABLE C.

Salt Content and Reaction of Soils of Type 1C.

Site.	Depth.	Salt (NaCl).	pH.
	ins.	%	
39	0–18	Trace	6·61
	18–25	Trace	7·19
	25–36	Trace	6·90

B. Brown soil types.

—associated with granitic or gneissic rocks.

4 types of brown soils were recognised and mapped.

TYPE 2A.

Rich dark brown heavy textured soils somewhat variable in profile.

The profile consists of a rich dark brown gritty loam to sandy clay loam a few inches deep on a red brown sandy clay subsoil which becomes heavier and either more chocolate coloured or yellow with depth. Lime occurs in the subsoil from about 18 inches.

Timber: York gum.

TABLE D.

Salt Content and Reaction of Soils of Type 2A.

Site.	Depth.	Salt (NaCl).	pH.
	ins.	%	
19	0– 5	·02	7·02
	5–16	·04	8·12
	16–24*	·13	8·80
	24–36*	·18	8·85

* Lime present.

Site 20 which had been affected by saline seepage water showed similar reaction values and textures.

TYPE 2B.

0 to 6in.: grey brown gritty loamy sands to sandy loams.
below 6in.: yellow brown to red brown gritty sandy clay with some lime accumulation in the deeper subsoil.
below 3ft.: decomposing granitic or gneissic rock.

TABLE E.

Salt Content and Reaction of Soils of Type 2B.

Site.	Depth.	Salt (NaCl).	pH.	Site.	Depth.	Salt (NaCl).	pH.
	ins.	%			ins.	%	
21	0– 6	·01	6·37	45	0–10	·01	6·59
	6–12	·04	8·21		10–21	·06	8·45
	12–36*	·08	8·90		21–38*	·08	8·80
	36–44	·11	8·81		38–45*	·06	7·02
27	0– 2	·03	7·00	51	0– 3	·01	6·95
	2–14	·06	8·68		3–18	·03	8·24
	14–21*	·12	8·83		18–24	·03	8·50
	21–40*	·11	8·92		24–30	·01	8·72
					30–38	·02	8·76

* Lime present.

TYPE 2C.

Brown to red brown sandy loam about 9in. deep on yellow brown, red brown to brownish red gritty clay with no lime. Decomposing rock at about 2ft.

TABLE F.

Salt Content and Reaction of Soils of Type 2C.

Site.	Depth.	Salt (NaCl).	pH.	Site.	Depth.	Salt (NaCl).	pH.
	ins.	%			ins.	%	
23	0– 9	·005	6·65	44	0– 3	·03	6·20
	9–18	·007	6·82		3–14	·04	6·70
	18–24	·007	6·78		14–24	·06	8·18
					24–30	·06	8·22
24	0– 7	·005	6·34				
	7–16	·005	6·67				
	16–24	·005	6·92				

TYPE 2D.

0 to 9in.: brownish grey loamy sand to gritty sandy loam.

below 9in.: yellow brown with grey and reddish mottling sandy clay loam to sandy clay. Pipe clay may occur at 5ft.

TABLE G.

Salt Content and Reaction of Soils of Type 2D.

Site.	Depth.	Salt (NaCl).	pH.	Site.	Depth.	Salt (NaCl).	pH.
	ins.	%			ins.	%	
47	0– 8	Trace	7·02	50	0– 9	Trace	7·52
	8–21	·02	7·62		9–18	·03	8·46
	21–24	·03	8·14		18–24*	·04	8·78
	24–36	·07	8·26		24–30*	·04	8·74
	36–48	·15	8·20		30–48*	·07	8·86
	48–72	·21	7·80		48–55*	·10	8·74
Water rose to 56in. and contained 1,130 grains of salt per gallon.					55–78	·18	8·08
				Water rose to 65in. and contained 780 grains of salt per gallon.			
49	0– 3	·02	6·97				
	3–11	·06	8·34				
	11–30	·08	8·68				

* Lime present.

C. Other soil types.

TYPE 3.

Black earth associated with a basic dyke.

Brownish black crumbly clay with a friable clay subsoil and lime accumulation at 2ft. Decomposing greenstone occurs at 2¼ to 3ft. This soil occurs as a strip coinciding with a basic dyke. It cracks badly when dry and, consequently, is difficult to work. In the virgin state it carried needlebush (*Hakea Preissii*).

TABLE H.

Salt Content and Reaction of Soils of Type 3.

Site.	Depth.	Salt (NaCl).	pH.	Description.
	ins.	%		
18	0– 9	·02	7·84	brn. blk. crumbly clay.
	9–22	·02	8·52	brn. blk. friable clay.
	22–32*	·07	8·48	brn. blk. calc. clay.

* Lime present.

TYPE 4.

Dark brownish grey clays with ferruginous gravel. These soils occur on the slope of a small ridge which originally carried morrel. They are slightly acidic to alkaline in reaction and showed surface accumulation of salt.

TYPE 5.

Grey tenacious clay, mottled orange and red in the subsoil at 9 to 18ins. The surface is more or less cracked during the dry season and bare patches, showing surface accumulation of salt, are common. An acidic reaction (pH 5 to 6) characterises the type which probably resembles certain soils of the moort (*Eucalyptus platypus*) country. In the virgin state it carried mallees including *Eucalyptus annulata*; *Wilsonia humilis* commonly grows on the surface of the soil; Barley grass (*Hordeum maritimum*) is characteristic of the cleared areas.

If well cultivated this type grows a good wheat crop in a heavy rainfall season.

D. The Valley Soils.

The valley soils along the Beegenup creek are essentially very variable and show the effect of layering owing to the method of deposition of the material in the past. The textures are generally of the sandy loam class but clay or sandy clay layers may be interposed more or less haphazardly. Surface colours are generally grey to grey brown and chocolate. These colours may extend to the subsoil but orange mottlings and yellow shades are generally noticeable in the lower horizons.

Salt crusts are common: where the valley has been cleared a bare, crusty surface has developed, probably as a result of wind erosion, and is referred to as a salt pan; where the timber, mainly york gum and some flood gum (*Eucalyptus rudis*), remains the surface is generally slightly crusty but friable, the A horizon apparently being still intact. This area is called a salt flat. Rushes and barley grass (*Hordeum maritimum*) also grow on the salt flat.

The analyses of samples from profiles of the valley soils are as follows:—

TABLE I.

Salt Content and Reaction of Soils of the Valley.

Site.	Depth.	Salt (NaCl).	pH.
	ins.	%	
8*	Crust†	7·52	8·05
	0–17	·74	8·33
	17–24	·98	8·06
	24–30	1·44	8·10
	30–36	·89	7·85
	36–57	·30	7·87
	57–69	·37	7·74
Water rose to 32in. and contained 1,380 grains of salt per gallon.			
10	Crust†	6·83	6·11
	0–12	·62	5·70
	12–24	·15	7·16
	24–39	·29	8·20
	39–48	·41	7·85
	48–	·41	8·34
Water rose to 53ins. and contained 1,380 grains of salt per gallon.			

Site	Depth.	Salt (NaCl).	pH.
	ins.	%	
9	Crust†	4·86	5·81
	0–18	·24	7·07
	18–24	·13	7·70
	24–33	·36	7·86
	33–36	·51	7·82
	36–54	·47	7·92
	54–60	·28	7·90
	60–66	·36	8·10
Water rose to 50in. and contained 1,420 grains of salt per gallon.			
14	Crust†	5·75	6·80
	0–20	·59	7·58
	20–42	·47	8·24
	42–	·62	8·21
Water rose to 36ins. and contained 2,250 grains of salt per gallon.			

* Salt pan. † 0 to ½in. deep.

E. Saline Soils of Seepage Patches.

The profile characteristics of the saline soils of the seepage patches resemble those of the adjacent normal soils except in salt content. Analyses of a number of soils from sites rendered saline by seepage of brackish water are given in Table J.

TABLE J.

Salt Content and Reaction of Soils rendered Saline by Seeping Waters.

Site.	Depth.	Salt (NaCl).	pH.
	ins.	%	
11	Crust*	4·20	7·01
	0–13	·18	7·95
	13–19	·12	7·90
	19–30	·15	8·42
	30–45	·18	8·25
	45–63	·30	8·16
	63–	·36	7·98
Water rose to 36ins. and contained 1,250 grains of salt per gallon.			
12	Crust*	1·96	6·55
	0–15	·12	7·47
	15–30	·16	8·27
	30–38	·26	8·08
	38–46	·28	8·10
	46–54	·30	8·16
	54–	·33	7·87
Water rose to 44ins. and contained 1,060 grains of salt per gallon.			
20	Crust*	8·29	7·03
	0– 6	1·06	7·90
	6–18	·26	8·55
	18–44	·34	8·66
	44–65	·58	8·38
Water rose to 18ins. and contained 1,520 grains of salt per gallon.			
25	0–10	·34	8·08
	10–22	·29	8·28
	22–40	·31	8·40
	51–55	·70	7·46
Water rose to 32ins. and contained 1,500 grains of salt per gallon.			
26	0– 8	·81	8·10
	8–22	·45	8·16
	22–36	·46	8·53
Water rose to 18ins. and contained 1,410 grains of salt per gallon.			
	ins.	%	
28	0– 3	1·02	6·92
	3–12	·35	8·32
	12–23	·28	8·62
	23–33	·31	8·68
	33–63	·34	8·66
Water rose to 34ins. and contained 1,490 grains of salt per gallon.			
30	0– 1	·56	6·59
	1–17	·08	6·42
	17–30	·11	8·05
	30–78	·26	7·65
Water rose to 41ins. and contained 1,170 grains of salt per gallon.			
32	0– 1	·77	5·54
	1–12	·07	5·84
	12–23	·01	5·95
	23–45	·03	7·26
33	0– 1	·64	5·66
	1– 6	·03	5·99
35	0– 1	1·11	6·67
	1–11	·14	6·22
	11–18	·11	6·44
48	Crust*	1·76	7·48
	0–13	·15	8·24
	13–22	·11	8·36
	22–46	·09	8·72
	46–62	·14	8·46
Water rose to 49ins. and contained 900 grains of salt per gallon.			

* 0 to ½in. deep.

EXPERIMENTS IN THE CURING OF TOBACCO LEAF WITH THE ASSISTANCE OF ETHYLENE GAS.

(A. SHARP, Tobacco Adviser.)

During 1937, information was received from the Imperial Institute of Agriculture regarding the beneficial results which had been obtained experimentally in Germany and Italy from the use of a number of "narcotic" gases such as Ethylene, Acetylene and Nitrous Oxide in the curing of tobacco leaf.

The effect of very small quantities of ethylene gas on the ripening of fruit is well known, and this gas is now being used commercially in this State for the artificial ripening of citrus fruits, bananas and pears. The effect of the gas on the ripening of fruit is recognised to be due to stimulation of the enzyme processes, and, since the changes which take place in tobacco leaf during the curing process are also the result of enzyme action, it had been suggested that the quality of the leaf might be favourably influenced by the action of ethylene.

It was therefore decided to carry out a series of experiments with ethylene gas at Manjimup during the 1938 curing season. Very little information was available regarding the technique of using the gas except that the temperatures varied from 20 deg. to 28 deg. Centrigrade, with atmospheric humidity from 75 per cent. to 90 per cent., and the proportion of ethylene to air in the curing chamber usually varied from 1 in 5,000 to 1 in 10,000.

The Department's curing kiln at Jardee was utilised for carrying out preliminary trials with the gas. A length of rubber tubing was led under the wall of the kiln and its outlet supported at the centre of the floor. The outside end was connected to a 30 inch cylinder of ethylene gas through a gauge which measured its output.

The first kiln to be cured was filled with ripe leaf from the Department's fertiliser and variety plots, and, during the yellowing process, a quantity of ethylene gas equal to 1/5000 of the cubic capacity of the kiln was introduced hourly. Yellowing was started at 85 deg. F. and the temperature was gradually raised to 100 deg. in about 27 hours. As the kiln contained leaf from six varieties of tobacco it had been anticipated that considerable difficulty would be encountered in getting each variety to cure satisfactorily owing to the tendency of certain varieties such as "Sport" to yellow more rapidly than "Hickory Pryor" It was found, however, that all six varieties yellowed at approximately the same rate, and all had developed sufficient colour 27½ hours from the commencement of the cure to enable ventilators to be opened and the fixing process to be commenced. It was considered that the time taken by the leaf to colour up was somewhat less than would have been the case without ethylene, particularly in the case of "Hickory Pryor" leaf. The application of gas was discontinued when yellowing was complete, and the remainder of the cure was carried out in the orthodox manner.

The leaf used in this preliminary trial was grown on moist flat country, and, being thoroughly mature, would be expected to present little difficulty in curing a good colour without the use of ethylene. It was desired to test whether the use of gas was likely to be advantageous in the case of leaf grown on hillside land. Such leaf is frequently of heavy texture, tending to coarseness, is more or less damaged by scorching, and usually fails to yield a high proportion of bright leaf.

Arrangements were accordingly madė with Mr. G. F. Combs to purchase sufficient uncured leaf of this description to fill two curing barns. Two barns of similar size and construction were made available by Mr. Combs. The leaf was picked on 15th and 16th February, and the barns filled simultaneously. Curing was commenced at 5 p.m. on the 16th. Ethylene gas was introduced to one barn at the rate of ½ cub. ft. every hour. This quantity was approximately 1/5000 of the volume of air in the barn. As the barn was constructed with bag walls treated with cement wash, and had not been built to be specially gas-proof, it was considered advisable to admit fresh gas at hourly intervals in order to maintain the concentration. No ethylene was introduced into the "control" barn.

The yellowing process was carried out at a temperature of 90 deg. rising to 95 deg. in 36 hours. By this time the yellow colour was considered slightly more pronounced in the ethylene treated barn, but it was becoming obvious that neither barn was going to yield a good colour of leaf. Yellowing was continued until 6.30 a.m. on the 19th, 61½ hours after commencement of the cure. Neither of the barns had developed a good colour, most of the leaf in both having shown a tendency to go from green to a dirty brown colour. From experience gained later in the season, it is considered that this leaf had been adversely affected by a series of extremely cold nights prior to picking, although the damage did not become apparent until after curing had started. Curing of both barns was completed by noon on 21st February, and the leaf was bulked the following day.

Grading of the leaf was carried out about the middle of July, and, as was expected, only a very small proportion of the total quantity could be graded as "bright."

The following table gives the result of grading:--

——	Total Weight of Cured Leaf.		Weight of Bright Leaf.		Percentage Bright.
	lb.	oz.	lb.	oz.	%
Barn 1—Control	281	12	6	2	2·17
Barn 2—Treated with Ethylene ...	299	15	8	1	2·68

It will be noted that the use of ethylene did not result in an appreciably higher proportion of bright leaf.

In order to determine whether the use of the gas effected any improvement in smoking quality, samples of leaf from both barns were forwarded to the Council for Scientific and Industrial Research, Canberra, to undergo smoking tests. The smoking test report has just come to hand and it indicates that, so far from improving the leaf, the use of ethylene has had a detrimental effect on aroma.

It may be that the use of ethylene gas in curing involves some modifications of orthodox flue curing practice to obtain satisfactory results, and in this respect further experimentation is necessary. On the other hand it has now been clearly demonstrated over a number of years that leaf grown in the Manjimup district on suitable soils and allowed to mature thoroughly in the field before picking, can be cured a bright colour, and with quite satisfactory smoking qualities, without any adventitious aids, and thus it is unlikely that the use of ethylene, or any other gas, will ever become a standard practise in tobacco curing in the Manjimup area.

THE MOULT AND FEEDING OF THE YEARLING HEN.

By G. D. SHAW,
Poultry Adviser.

Moult.—Fowls and other birds have an annual reconditioning of the plumage, and they will, at this period, cease laying eggs. Odd birds have the stamina to produce while in the moult, but these are exceptions and are not considered in this discussion.

The growing of new feathers yearly after the old and worn feathers have dropped is called the annual moult.

The moult is nature's method of dressing the fowl in new fashion previous to the period of reproduction. All old feathers are discarded and new ones are grown. The time during which this reconditioning is taking place is called the "moulting period" and this period may extend from as long as four months to as short as six weeks.

Apart from the annual moult it is possible that the fowls may pass through partial moults, for example:—When the early hatched pullets go into the neck moult in autumn and when at other periods the birds have received a check through sickness or possibly due to the distress of a heat-wave.

The longer a bird will lay into the autumn the quicker she will be in passing through the moult, and it can therefore be seen that the later the moulter the better the layer. On the other hand the early moulter is generally a poor producer and should be culled as soon as she is noticed going into an early moult.

We must refer to the article on "Culling" Spells "Profit." When we have found the poor producer ceasing to lay, at between November and early February, we have been advised to cull her because she will be eating into the profit. With this poor layer it will be noticed that the comb is shrinking up and is getting very hard in texture. Although she will not then go into a moult she will hang in this condition for months and from about the first week in February she and her sisters of like kin will then begin to cast feathers. This casting of feathers will be noticeable in the unculled flocks while in those flocks whose owners have learned the value of culling out the poor producer the moult will not be evident until about the early March or even later (this depends on the severity of the culling).

In this article it is not intended to give the details of the procedure of the moulting of the feathers. Suffice it to say that all the feathers will eventually fall and their places will be taken by a new growth, and so the bird will be in clean feathering before she begins her new laying season.

Three Kinds of Moulter.—There are three kinds of moulters. First of all, the continuous moulter, the one which appears to have clean unworn feathers throughout the year. This bird will generally fall into the class of layer called the "Dud." The next class is the early moulter. This class contains all those birds which are renowned for their short laying season. Into this class are those which cease laying about the November and then wish to rest until the following July. The next class is that of the late moulter. This class contains all those birds which have laid heavily for 12 months and moult quickly and are then ready for the next year's lay at about the same time as her sisters who have been in the moult for a much longer period.

In Western Australia the continuous moulter and the early moulter are now few and far between. Producers in Western Australia have taken the culling to heart, and on very few farms which have had the benefit of a culling demonstration,

will there be seen any birds of the two before-mentioned classes. They have been culled out months before the annual moulting period is at hand.

Late Moulter.—It is the late moulter we wish to study. We should be able to assist her to "come through" the moult with as little strain as possible. For a strain it is, and all possible assistance should be given to the bird.

The late moulter has been laying for twelve months. She has been kept in good condition by the judicious balancing of the feeds in the rations. She is not showing any undue strain due to her heavy laying, and if she is assisted through the moult she will continue to give eggs for another nine months. And in numbers equal to that laid by her in the previous corresponding nine months (from the July to the March).

During the period of heavy laying we have been feeding so that the body has been kept in the best of condition, and we have also been giving sufficient food in order for the fowls to lay heavily without danger to the constitution. We have fed body and also eggs into the fowl, and she is responding with high production and good body condition. It is often questioned whether we should allow the heavy layer to continue in the lay until she elects to go into a natural moult or whether we should force the layers into a moult at some predetermined time each year.

When one culls out the poor producer at the moment it ceases profitable production, one will have, at the time of the moult, only good layers on the farm, and these layers should have production high enough to ensure each bird a place in the breeding pens (except for any defects which although they will not affect egg production are not desirable when the bird is considered as a breeder).

Forced Moulting.—If such is the case we should therefore see that the layer comes through the moult in the best condition possible for breeding, and to that end it is advisable to recommend that all the layers which are to be kept for another year should be "forced" into a moult, so that they will have plenty of time in which to recuperate and grow new feathers before they are required for the breeding pens.

It is therefore recommended that the layers are all "forced" into the moult at the end of March, and are then given a three months' rest from laying. During this period they will have sufficient strain in the growing of new feathers without having to put up with the strain of laying at the same time.

Feeding the Moulting Hen.—If the food has been sufficiently balanced the birds will not be suffering strain from heavy laying. Their egg production will be in the range of 45%. Their ovaries and oviduct in full bloom. Feathers and eggs need protein, and if we are to have feathers, the production must nearly cease. While all portions of the rations contain some protein it is recognised that the only way to give a sure fluctuation of the protein content in the ration is to increase or decrease the highly concentrated animal protein. In Western Australia the only proteins available in high concentrated form are the meatmeal and the dry buttermilk. In all references to the alteration of the protein, meatmeal is therefore the means applied when mentioning protein. The buttermilk is left consistent.

When there is any reduction in the proportion of protein in the ration, it is evident that the production will suffer. So that at the period near the end of March we have a favourable condition for causing a "forced" moult. The birds are near the natural period of moulting and they are easily forced out of lay. If the protein in the ration be reduced it is certain to affect egg production, and the

birds will then start to drop the old feathers, and egg production will practically cease. The one danger to remember is that the growth of new feathers consumes as much protein as does the production of eggs. Therefore, if the protein is reduced in order to ease off egg production it is evident that *once the feathers start to drop we will have to replace the protein* so that the bird will be able to grow new feathers without undue strain.

Assuming that we have a flock of layers "well culled," and laying the 45% so desired in March. In order to cease the production the protein (meatmeal in Western Australia) will be withdrawn from both the morning mash and the dry mash. This feeding will continue until there is shown a marked decline in egg production. With well fed birds the waiting will continue for about three to four weeks. In other cases one week only is sufficient. After the production has shown a sharp decline the birds *must be given a ration similar to that fed to them when they are in heavy lay.* The birds are now making new feathers and to do this satisfactorily they want high percentages of protein in the rations. *Do not starve the moulting hens.*

The days of starving the moulting hens are past. When one realizes that the feathers contain a high percentage of protein, one can then feed that ingredient to the birds, and so assist the growth of the new feathers. Any starvation at this period will only prolong the moult, and cause a severe strain on the constitution of the bird. The bird will not then be satisfactory as a breeder, and also she will take a longer period in which to complete the moult.

Should the Hens be Forced Into a Moult?

It may be questioned whether the forcing of the good layer into the moult will be as profitable as allowing the birds to take to the moult naturally. Eggs are at a high price during March, April, May and June, and any loss of production at this period may be a severe drain on the finances of the farm.

Against this is the production of the young laying pullets which should *all* be in full lay in March onwards.

If we are to take the long view and realise that the bird which has laid heavily for twelve months, and is also expected to continue to lay heavily for another year, must be in the best of condition all the time in order to stand up to the strain, we will appreciate that a rest of two months and the loss of the eggs during that time is more than fully repaid when the bird starts in June and *can* continue heavy production for another year. The bird which is allowed to lay herself out will not come into the lay as soon as those which have been made to rest and she will not be as strong as her sister which has the extra two months' rest. Give the rest and the bird will be able to lay into the next winter whereas if they are not rested you will find that they will fade away about the November and December of the year. Of course, a few exceptional birds will be able to carry on. But a few exceptional birds will not be as profitable as a lot of birds which can carry on because they have been allowed to recuperate for two extra months.

Therefore make the layers moult in April. Reduce the protein until the egg production has declined and then feed on the high production rations.

Let us now examine the flock of hens which are beginning the *forced April moult.* They will be laying 45 per cent. production and the protein is reduced in both the wet and dry mashes. The egg production will continue for a fortnight or three weeks, and then a sharp decline is noticed. Immediately this happens the proteins are again added to the rations. The birds will drop their old feathers and they will be under no undue strain during the regrowth.

Cull During the Moult.—Soon one will notice that some of the birds have drifted into the "dud" class of layer. Their comb has shrunk up—their body has also shrunk up—the comb appears as if it has been drawn into the head—the beak seems as if it has grown longer, and the eyes are taking on a shrunken look—a typical "dud"—*and so it is.* This bird has ceased to be profitable, and if kept will take until the following spring before coming into the lay again. On the other hand the sisters which have retained the supple comb (although the colour has faded) will have the large body showing capacity (width and depth). The eyes will be bold and the beak short and strong. Open up one of each class, and this is what you will find. The "dud" will show that the ovaries have dried right up, and will be about the size of a pea, while the other bird will give you the distinct opposite. The ovaries will show an effect similar to a bird in full lay. The yolks will be in some cases fully developed and graded down showing that the moult has been no strain, and as soon as the feathers have been fully grown the food will then be transferred from feathers to eggs in the shortest possible time.

It will be noticed that the birds which do not collapse will begin the lay practically simultaneously. The percentage of production will rise from the nominal 5% during this moult to the desired 60% in about four weeks. In plenty of time for those birds to be in the breeding pens and with a supply of eggs sufficient in quantity to keep the incubators fully supplied in the early portion of the hatching season. On the other hand, if the birds are to go into the moult naturally they will come out of the moult naturally, and time taken to reach the heavy lay again will be too long to be of much use in keeping the machines filled in the early part of the season.

Health of the Flock During Moult.—It will be noticed that in the whole process, the health of the flock has been the main consideration. Ease the lay by reducing the protein. Add the protein when egg production eases, and feathers are dropping, and the birds will respond quickly. Let the birds lay themselves out, and there is a strain on the constitution which takes times to repair. Time which is too valuable to waste.

It is therefore considered more economical to force the moult in April than to allow the birds to abide their own time.

It must be understood that the bird which breaks down when going through the moult of April to June is of little use on the farm. She should be considered similar to her younger sister who will not lay enough eggs to pay for her feed. Cull the bird which takes on the form of the "dud." And all those which are left in the flock will lay a percentage of eggs in the same proportion as the young pullets month for month.

If the flock has been continuously culled as suggested in the article "Culling Spells Profit," the numbers at the end of the first moult will be about 50% of those which were placed in the pens as good pullets fifteen months before. But every bird has been a profit earner for every month in the year (except during the moult). During the moult the birds are consuming food for which they must eventually pay, and their means of paying off that debt is by the eggs they will lay during the next season. Therefore, the sooner they come into the lay in June, and the longer they can sustain that lay, the greater will be the profit. It will be realised that the moulting bird is at a disadvantage, for she will begin her second season of egg production when the prices of eggs are dropping to a figure which is governed by London parity prices, and the profit of egg production over feed costs per week will not be as great as when she started fifteen months before when

eggs were 2/ per dozen. She has created another debt equivalent to approximately ten or twelve weeks at 2½d. and she has to redeem that debt before the farmer can consider he is receiving a profit.

It will be in the middle of September before the debt is paid. If any factor is allowed to lengthen this time for redemption the longer the farmer will have to wait for his share of the profits.

Feeding the Hen.—When the bird is through the moult it can be suggested that it will not be as active as the younger bird, the pullet. It is also a well-known fact that the older the bird the greater tendency to place on fat. We must, therefore, retrace our steps and again study *How to Feed Your Fowls,* Journal of Agriculture, Vol. XIII, Page 465. It was explained that the bird should have a ration so balanced to meet all the requirements of body and eggs.

The Requirements of Body and Eggs, and therefore, we are asked to study the requirements of the yearling layer. The hen which has passed through the first moult is now ready for the breeding pens. She has proved that she can give tweve months good production and has gone through the moult successfully. But she has reached a more benign stage, she is not as flighty as her younger sister. Therefore, she will not be able to use the energy forming portions of the rations as quickly as the younger sister. She will then store up the surplus, and in storing up the surplus will immediately begin to get fat. Layers of fat in all parts of the body. The fact that the fat is being stored up through a too high percentage of fat forming foods in the ration naturally must suggest that the protein is in short supply; and the protein being short supplied will immediately be evident in the percentage of egg production. If under any circumstances the bird places on fat, the egg supply must suffer, and more so when the bird has passed the first moult. Therefore, if the bird is going to put on fat the egg production is reduced due to a lack of sufficient protein in the food.

If one takes the trouble to notice a flock of white leghorns, one will notice that the young pullet will be in good condition, and will be laying well while the older bird will be placing on fat, and will not be laying as well as she could. This immediately suggests that the food for the pullet is not the correct food for the hen. And such is the case. The older bird being less active will not be able to consume the same percentage of energy forming food as the young, and more flighty pullet. Therefore, in order to balance the ration for the older hen the protein *must* be increased in proportion. It has been found that the yearling hen, or the hen after her first moult will need approximately 25 per cent more meatmeal in the ration than that necessary for the pullets. In order to ascertain this figure the suggestion given in *"How to Feed Your Fowls,"* page 468 is used. The dry mash is used when endeavouring to effect a balance. We are to keep the one mixing of the morning wet mash for all breeds and ages, and we are to balance the rations for breeds and ages by the addition of extra protein to the dry mash hoppers. The bases given are ½ measure of meatmeal for White Leghorns.

⅝ measure of meatmeal for Rhode Island Reds.
11/16 to ¾ measure of meatmeal for Australs and other heavy breeds.

These measurements are for the pullets. Those who have used these measures have found that they are satisfactory for the pullets, but are low for the hen. The suggestion has been invaluable for demonstrating the necessity for extra meatmeal when feeding birds in their second and third year.

An example of extra feeding of meatmeal to the older hens compared to pullets is given. At a farm in the country it was pointed out that the pullets were doing

80 per cent. lay, while the hens were not above 55 per cent. during the spring peak (September). On handling the birds it was found that the hens were carrying too much fat, and the farmer was advised to increase the meatmeal by 25 per cent. for about seven days, and watch the result. The farmer accepted the advice, and seven days later gave the results.

At the time of the visit	50 per cent.
First day after	50 „ „
Second day after	52 „ „
Third day after	56 „ „
Fourth day after	67 „ „
Fifth day after	70 „ „
Sixth day after	73 „ „
Seventh day after	77 „ „

The slight addition of meatmeal thereafter continued to give the extra results. The farmer was convinced of the necessity of extra meatmeal for the hens. The birds were Leghorns.

When the White Leghorn passes through the first moult the proportion of meatmeal to be used in the dry mash can be as high as ⅝ measure instead of the ½ as for the pullet.

When the Rhode Island Red passes through the first moult the proportion of meatmeal to be used in the dry mash can be raised between 11/16 to ¾ measure, whilst the proportion for Austral yearlings is in the vicinity of one full measure.

If the methods of ascertaining the proportions required are based on the practice as suggested in *"How to Feed Your Fowls"* page 469, poultry farmers will have little difficulty in keeping the fat down and the egg production up.

It must be understood that the bird which has passed through the second, and for that matter, any other subsequent moult, will be still more liable to place on fat, and therefore the proportions of meatmeal must be increased after each moult. Birds which have been fed a properly balanced ration for several years, are still in good fettle and the egg production is comparable to that of the pullet beginning the first year.

Unfortunately, the second, and any subsequent lay, is only for the months of July to March (nine months) while the first year's lay extends for the period, February or March, to March.

2nd Year Culling.—After the hens have completed the moult and are laying, the farmer should continue to *cull* as was performed during the first year of lay. The hens will produce in approximately the same percentage as the pullets, if one has already eliminated the *dud.* (This dud should be culled during the process of the moult.) The sprinter will again show up and should be culled out as soon as she ceases profitable production. It is here the farmer should concentrate. As the hen has approximately only nine months of laying, it is not profitable to allow the hen to stay on the farm one day too long. The farmer has had one year of culling, and is becoming proficient in anticipating the "fence sitter." This bird will have the comb which has a texture similar in feel to the top portion of the human ear, and the moment it "falls off the fence" the comb will begin to take on the feel of felt. It will then begin to show up as if it were a "dud." It is here the farmer should concentrate. He knows what is going to happen and he should inspect closely for any signs suggesting a fall in production; the bird is then

culled. It will be found that the reduction in the flock will be similar to the reduction in the pullets. And by the time the second moult is completed, the flock of hens will have dwindled to approximately half that of the previous July. The percentage of culling during the third year is heavier than that of the second year, and as the birds grow older the percentage of culling increases.

Partial Moulting.—Apart from the annual moult, the birds are apt to have what are termed false moults.

Firstly, the young pullets may suffer a partial moult in the first autumn. This may be due to change of management, such as the change of food, or a change of housing when the pullets are beginning to lay. Any sickness in the March to June period may be the cause of a partial moult. And in all cases the partial moult may develop into a full moult. In all cases the moult will cause financial loss to the farmer, and all practices should be adopted to carry the birds through the season without a relapse into a moult which is not natural to them.

To this end it is advised that the pullets should be shifted to their laying quarters as soon as possible. If the shift takes place before the pullets are five months old they will have sufficient time to settle down and become comfortable in their new quarters. They must not be overcrowded, for overcrowding will cause distress, and any distress may be considered sufficient excuse for a moult. See that the pullets are fed sufficient food. Many a partial moult is caused because the pullets are fed insufficient food. They have been well reared from the chicken stage, and are in the best condition for a heavy lay; therefore, if for any reason the food is insufficient the pullets will not be able to obtain the amounts necessary for high production. As they have been bred to lay they will draw on the body for any deficiency and the constitution will suffer. The pullets will then go into a partial moult, and in some cases a full moult will take place—with eggs at 2s. per dozen. The pullets should be treated gently. Any frights will have a tendency to induce a partial moult.

Hanging in the Moult.—When the fowls have moulted producers are inclined to expect the birds to lay immediately the new growth of feathers have begun. In some cases the hens have been condemned as "hanging in the moult." At this stage we must be prepared to consider whether the birds are ready for the lay, or whether they are still growing the feathers. The birds are not ready for laying until they have *completed* the growth of the new feathers, and the farmer would be well advised to handle the fowls to see the progressive growth of the feathers.

It is of little use expecting eggs until the growth ceases. On the other hand it is not unusual for the hens to "hang in the moult," and this can be remedied if the farmer is prepared to realise that perhaps the feeding is not quite right. When there is any doubt that the birds are "hanging in the moult" it is best to examine the feather growth. If the growth is complete the birds are ready to lay, but if the ration is not right the birds *cannot lay.*

If the feathers are grown and the farmer is perturbed because the birds are not in the lay it is an easy matter to find the cause. The addition of more meat-meal in the morning mash will generally find the fault.

Extra Meatmeal.—It is advised that for three or four days in succession the meatmeal should be "doubled up" in the morning mash, and then revert to the base. After a period of about three or five days the birds should show egg production; it is a sure sign that the protein proportion of the ration is a little on

the low side, and has been short supplied for the period of the moult. There will be an immediate response if the feathers are fully grown, and that response is a definite guide of shortage of egg-forming ingredients in the rations. The farmer should then study the ration, the laying condition of the bird, and the colour of the droppings. All three will be factors in determining the amount of meatmeal required.

If, on the other hand, the birds do not respond to the extra ration of meatmeal, the farmer can be sure that the feathers are not fully grown.

Birds coming into lay can be similar to the runner—they will wait for the starter's gun. In this case the starter's gun is the extra ration of meatmeal.

An example of the lay of a well-culled flock of hens passing through the moult. These hens had been forced to rest from the first of April, and the laying was as follows:—

June	1st	7th	14th	21st	30th
eggs	12	12	30	50	58
July		7th	14th	21st	31st
eggs		58	62	68	72

These hens were apparently through the moult about the 7th June. All hens were laying on the 30th March, the production being 46%.

If your hens are not all laying in the beginning of July, add the extra meatmeal, and closely watch the results. It should be followed by a marked increase in the production of eggs. Thereafter apply this practice whenever the birds are not laying up to expectations. Should the response to the extra meatmeal be sudden, you can be sure the meatmeal has been a little low in proportion to the other ingredients. If there is no response you may be sure your birds need "culling." *It is necessary to remember that the continued use of double amounts of meatmeal is dangerous.* Whilst on the other hand the doubling up now and again is the farmers' method of checking the feeding management.

Natural Moult.—Having dealt with the hens which are to be kept for another year, and explained how they are to be managed through the moult, it will be evident that at some period in the management of the farm the farmer is determined to dispose of the aged hens at the end of the current year. When this is decided it will be found advantageous to allow the bird to lay for as long as possible. The extra eggs at increasing prices are so much more profit, and no attempt should be made to force the birds out of production in April. It should be the aim to keep the bird in production for as long as possible, and to that end the farmer should slightly increase the meatmeal, and also the buttermilk. Note: This is the only time the buttermilk is increased for laying flocks. These two increases will tend to force a few more eggs out of the hens at the time when they are due for the annual rest. The increases should begin about December and continue until the moult is well established.

Disposal of Stock.—Do not wait for the full moult before disposing of the stock. As they go out of production send them to market and so have them in reasonably good feather. If the farmer waits until the moult is well advanced he will not receive as much as if they were carrying feathers. Should the farmer delay the disposal until the new feathers have arrived he will not be repaid for the extra feed and trouble entailed. It is advisable to *send to market immediately the bird is going out of production,* and before the feathers have started to drop.

HARVESTING AND CURING OF TOBACCO LEAF.

A. Sharp, Tobacco Adviser.

Under normal conditions at Manjimup the bottom leaves will be ready for harvesting about three months after the planting out of the crop. In the case of a crop planted about the middle of October, harvesting can be expected to commence about mid-January and continue until about the end of February.

The method of harvesting by cutting the stalk at ground level and curing the whole plant at once is no longer practised in the case of flue cured tobacco. The tobacco plant ripens progressively from the base upwards, and it is therefore obvious that, with this method, the leaves would be in various stages of maturity. In order to meet the somewhat exacting standards set by the manufacturers today, it is essential that every leaf picked should be as nearly as possible of the same degree of ripeness, and this is possible only by harvesting by the method known as "priming," whereby each leaf is picked separately from the plant as it ripens. Four to six pickings may be necessary, and a period of four or five weeks or more may elapse between the first and last pickings.

It is extremely important that the tobacco grower be able to recognise the proper stage at which the leaf should be picked. Probably more leaf is spoilt every year through being picked in an immature condition than through any other cause. Exact knowledge on this point can be gained only by experience. Generally speaking, ripening is shown by the colour of the leaf changing from dark green to a characteristic yellowish green. Just how far this yellowing ought to be allowed to go before picking will depend very largely on soil conditions and on the texture of the leaf. Very heavy bodied leaf frequently assumes a mottled appearance on ripening. Mature leaf also tends to become somewhat brittle, and on being folded between finger and thumb it snaps along the fold.

Under the very hot and dry conditions experienced in this State during harvesting, it frequently happens that crops grown on soils which have failed to retain sufficient moisture, or in situations exposed to hot, drying winds, fail to mature normally. The tips and edges of the leaves turn yellow and then brown through scorching while the rest of the leaf remains dark green. It is sheer waste of time and money to pick and cure such leaf as it does not colour properly in the curing barn, its smoking quality is very poor, and the manufacturers refuse to purchase such leaf at any price. The only advice that can be given in such a case is to cut the loss incurred in growing the crop, pull up the plants and burn them, and do not attempt to grow tobacco again on that particular area.

It cannot be too strongly emphasised that careful picking of the leaf is absolutely essential if success is to be obtained in curing. A careless picker can cause an enormous reduction in the value of the finished article, and those growers whose operations are on a scale sufficiently large to necessitate the employment of a number of hands would be well advised to spend some time at the beginning of the harvesting season in making sure that the pickers know exactly the proper stage of maturity at which to pick. Their work should be very closely supervised and the adoption of a system of periodically checking up the work of each individual picker would tend to keep the standard of work reasonably high.

The best time to pick is in the early morning from six o'clock to about ten. The leaf is then fresh and crisp, and the work is much less fatiguing than is the case in the heat of the day. Care should be exercised in the handling of the leaf to avoid bruising, and it should not be exposed to the sun's rays longer than is absolutely necessary as undue exposure causes wilting and scorching. The presence

of dew on the leaf will not matter provided that it is strung on the sticks and hung up within a few hours. Should a fairly heavy fall of rain occur during the harvesting period the gum which is normally present on the leaf surface is liable to be washed off. Picking should not be resumed until two or three fine days have elapsed, by which time this gum will again have made its appearance.

PRIMING.

The usual procedure is for the picker to break off the leaves separately from the stalk and place them in the crook of one arm with the butts pointing in one direction. When as many have been picked as can be conveniently carried in this manner they are placed carefully on sheets of hessian previously placed at intervals between the rows. When the sheets are full, the ends are brought over and hooked together to form a bundle, and they are placed on a cart or truck and taken to a stringing shed. An improvement on this method of transport is to provide hessian stretchers, about the same size as the ordinary ambulance stretcher, on which to place the leaf. These, when full, can be placed on the cart and, on arrival at the shed, can be slid on to the stringing bench. The use of these stretchers enables the leaf to be handled expeditiously with a minimum of cracking and bruising.

STRINGING.

The stringing shed is usually a more or less temporary erection of hessian stretched over bush poles and situated close to the curing barns. Its purpose is merely to provide shade for the leaf until it has been strung on the hang sticks and placed in the barn. The leaf is placed on benches in this shed with the butts pointing outwards. Conveniently placed to these benches are stands which support the ends of the hang sticks while the leaf is being strung. These sticks are usually about 4ft. 6in. long, and two types are in use in this State. The more popular type consists of 1½in. x 1in. hardwood fitted with a number of cross wires of 12½ gauge galvanised steel fencing wire, 18 to 20 inches long and spaced six or seven inches apart. The leaves are strung on to these wires by the fleshy butts of the midribs, care being taken to leave a small space, say quarter of an inch, between each butt. It is advisable to string the leaves back to back and face to face on these wires in order to facilitate the passage of a current of air across their surfaces during the curing process.

Another type of hang stick, which is less popular here although it is used almost exclusively in the Eastern States, consists either of sawn hardwood of similar dimensions to that previously described or of bush poles about 1¼in. in diameter. The leaf is hung from the stick by means of ordinary grocer's twine which is fixed about four inches from one end and looped round the butts of the leaves which are arranged in pairs, back to back, on alternate sides of the stick, the string passing over the stick in zig-zag fashion, and being secured four inches from the other end by a couple of half hitches. There is some difference of opinion among growers as to which type of stick allows of the more rapid handling of the leaf.

When sticks are filled they are carried carefully into the curing barn and suspended between the tier poles. It is essential for first class results that the barn be filled and the curing process commenced within a few hours of the picking of the leaf.

THE FLUE-CURING BARN.

During the flue curing process the leaf is subjected to varying degrees of temperature and atmospheric humidity, and a properly designed curing barn is one in which these factors can be regulated within reasonably close limits, irrespective of the atmospheric conditions obtaining outside the barn.

In the modern flue curing barn the temperature is regulated by a heating system consisting of one or two brick furnaces connected to a series of sheet iron flue pipes running across the floor, and exhausting into one or two chimneys. To assist in the conservation of heat and to avoid sudden fluctuations of temperature due to outside weather conditions, the walls and roof are built of some material which is a good insulator of heat. The degree of humidity is regulated by adjustable ventilators at ground level and in the roof.

Fig. 1.—Tobacco-curing Kiln erected to the writer's design at Manjimup for experimental work by the Dept. of Agriculture into the techniques of tobacco curing.
Photo. by Author.

SIZE OF BARNS.

The size of barn which will be found most convenient will depend largely on the area of crop to be cured and the amount of labour available. In this State, most of the tobacco plantations are comparatively small, usually from 5 to 15 acres, and rarely exceeding 25 acres. For small plantations, say, up to 15 acres, a number of small barns, each 12ft. by 12ft. inside measurement, and carrying four tiers of leaf, will be found most suitable. For areas greater than this, barns 16ft. by 16ft. with four or five tiers may be used.

The writer is very definitely in favour of the small barn. It is essential for good results that curing should start within a few hours of the leaf being picked, and the small staff which can be economically employed on the small plantation can fill the smaller size barn comfortably in one day, whereas two or more days would be required to fill the larger size. It is frequently found, also, that two or more distinct types of leaf may be grown on one plantation owing to variation in the soil or some other factor. These different types require different treatment during curing. Where small barns are provided they can be cured separately, thus enabling each to receive any particular modification of the curing process which it may require. In order to fill a large barn from a small area of crop, the grower is frequently tempted to harvest leaf which is slightly immature, a practice

which cannot be to strongly condemned. Immature leaf will not cure properly and is unsaleable. Where several small barns are provided picking can be done more frequently, thus permitting of a more evenly matured sample of leaf.

Generally speaking, one 12ft. by 12ft. barn will be sufficient for each four acres of crop, while a 16ft. by 16ft. will deal with each seven acres. While the capital cost of a number of small barns is greater than that of a smaller number of larger units having the same aggregate capacity, the higher proportion of bright leaf obtainable by the use of the former will more than repay the extra outlay.

The barns should preferably be built in a fairly well sheltered position on slightly sloping ground, the furnaces being built on the lower side in order to lesson the amount of excavation necessary. The accompanying sketches show the construction of a 12ft. by 12ft. barn to hold four tiers of leaf. A 16ft. by 16ft. barn would be built on precisely similar lines except for the arrangement of furnaces and flues.

MATERIALS.

Various materials may be used in the construction of the barn. The framing should consist of 4in. x 2in. jarrah, with wall studs set at 2ft. centres. This may be lined with either wood, corrugated iron, asbestos-cement sheets, or used fertiliser or wheat bags sewn together and treated with cement wash. The last named is the cheapest and is regarded as being more or less a makeshift, but it is very largely used in this State at present, and, where double bag walls well coated with a suitable cement wash have been used, good results have been obtained.

FORMULA FOR CEMENT WASH.

The following is a formula for cement wash which has proved quite satisfactory:—

1¼ gallons water.
12 lbs. cement.
2 lbs. lime.
1 lb. salt.
½ lb. alum.

Sieve salt and lime together. Add this to the water, then follow with cement, stirring while adding. Finally add the alum. Apply this mixture immediately with a fairly stiff brush, first wetting the bag wall. Two coats of wash are required, and the first coat may be made slightly thinner than the above.

Whatever material is used, it should be attached to both the inside and outside of the framing, and the heat-retaining qualities may be still further improved by filling the space between with dry earth or sawdust.

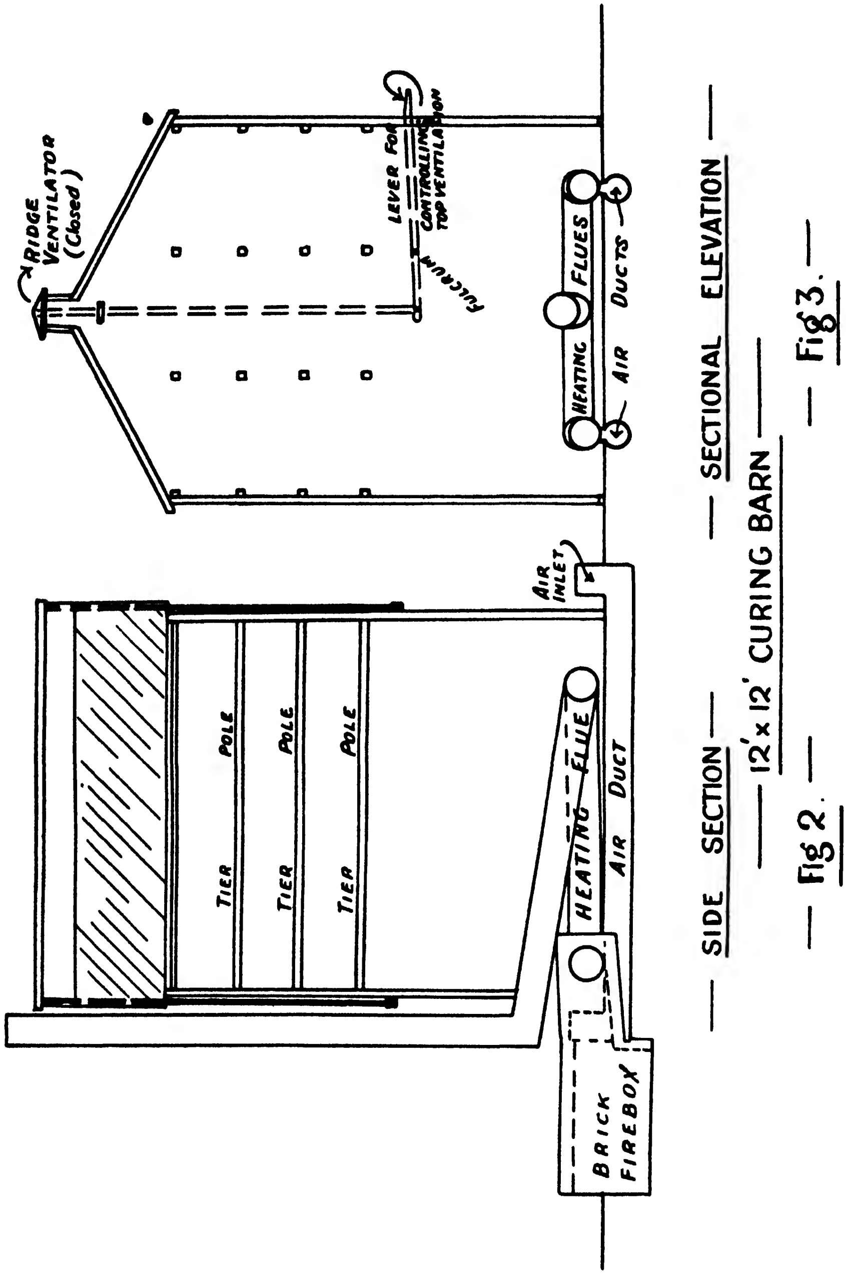
HEATING SYSTEM.

One brick furnace is capable of heating a 12ft. barn, but in the case of the 16ft. size best results will be obtained by using two. The firebox should preferably be built a foot or two away from the barn, and should be sunk below floor level so that a slightly sloping brick flue will connect it to the sheet iron flue pipes inside the barn just above floor level. These latter are usually about 11 inches in diameter and are made from 24 gge. galvanised iron. They may be arranged in a number of ways, the most usual being as in figures 4 and 5.

CONSTRUCTION OF THE FIRE-BOX.

The brick firebox is usually 18in. wide by 30in. high by 5ft. long, inside measurement. The walls should be 9in. thick and support an arched roof. The mortar should consist of a mixture of clay and sand, as this will withstand heat

far better than a cement or lime mortar. It is not advisable to incorporate iron arch supports as these expand when hot and may cause extensive cracking of the structure. To assist in controlling temperature a damper may be fitted at the base



Figs. 2 and 3. Drawings showing side section and sectional elevation, respectively, of open-ridge-ventilator type of 12ft. x 12ft. tobacco-curing kiln. For description of construction, etc., see text.

of the chimney, and it is advisable also to have a metal door at the mouth of the firebox. A piece of sheet iron held in place by a piece of timber or iron bar answers the purpose perfectly well.

VENTILATING SYSTEM.

A really efficient system of ventilation is essential. In the case of the small barns advocated for use here such a system can be constructed quite easily and at no great cost. It consists of two parts, an air inlet at ground level and an outlet at the apex of the roof. When the barn is in operation with both top and bottom ventilators open, the warm air inside the barn, being less dense than the cooler air outside, rises and escapes through the roof vent. Its place it taken by air drawn through the bottom ventilators, which in turn becomes warmed and rises. The steady current of warm air thus passing up through the leaf hung in the barn carries away the moisture given off by the leaf during the curing process.

The top ventilator should consist of an opening about one foot wide along the whole length of the ridge of the roof. A solidly constructed ridge cap made of timber covered with galvanised iron fits closely on top of the opening so that when closed it is as nearly airtight as possible. To open, this ridge piece is pushed up at each end by a perpendicular bar, sliding in an iron strap, and operated at its lower end by a lever working on a fulcrum. The amount of ventilation is regulated by an iron pin fitting into a series of holes, by which the lever is held in any desired position. This type of top ventilator is simple to construct and operate, offers the minimum obstruction to the egress of the moisture-laden air from the barn, and its efficiency remains constant irrespective of the strength and direction of the wind.

The best type of bottom ventilator consists of a series of ducts sunk in the floor of the barn immediately under the heating flues, and communicating at either end with the outside atmosphere through an adjustable shutter by means of which the amount of ventilation may be regulated. A narrow slit or series of apertures are cut in these ducts so that the incoming air is directed on to the hot flues and is thoroughly warmed before it can come in contact with the leaf.

SPACING OF TIER POLES.

The tier poles which support the sticks on which the leaf is hung are spaced at four foot centres. They may be made of bush poles or, preferably, of 4in. x 2in. sawn timber. The perpendicular distance between each tier should not be less than two feet, and the bottom tier should be at least 7 ft. 6 ins. from the floor. Thus a four-tier barn will require to be at least 14 ft. high to the eaves and a five-tier one 16 ft. If it is desired to allow more space between the tiers to accommodate very large leaf, the height of the barn will have to be made correspondingly greater. It is not advisable to have the tips of the bottom tier of leaf lower than 5 or 6 feet from the floor, otherwise they are liable to become scorched by the heat of the flues

The door should not be less than 6 ft. 6 ins. high by about 3 ft. wide. It should preferably be fitted at the furnace end of the barn and should open outwards. It should be of solid construction and fit the doorway closely. It is a good idea to fit a small window about the level of the bottom tier so that a thermometer hung there can be read without the necessity of opening the door.

FLUE CURING.

The first thing that the tobacco grower must understand is that curing is not merely a drying process. When the leaf is placed in the barn it consists of living tissue in which certain chemical changes will continue to take place until the leaf is killed. These chemical changes are normally accompanied by a change in colour from green to yellow. The art of curing lies in regulating the temperature

and humidity of the atmosphere surrounding the leaf so that, just as the web reaches the desired colour, sufficient moisture has been extracted to kill it and thus prevent any further chemical action which would cause the leaf to turn dark. No known method of curing will convert poor or immature leaf into good leaf, but good curing will further develop and fix the desirable qualities inherent in properly grown leaf.

It is quite impossible to lay down any hard and fast formula for curing tobacco. The behaviour of the leaf in the barn is influenced by many factors quite outside the control of the curer, such as the type of soil on which it was grown, weather conditions during growth and during curing, variety, degree of maturity, and so on, and it is only by experience that a high degree of skill in this branch of the work can be acquired. An understanding of certain general principles, however, will assist the beginner considerably.

The process consists essentially of three stages, viz.:

1. Yellowing the leaf.
2. Fixing the colour.
3. Drying out the midribs.

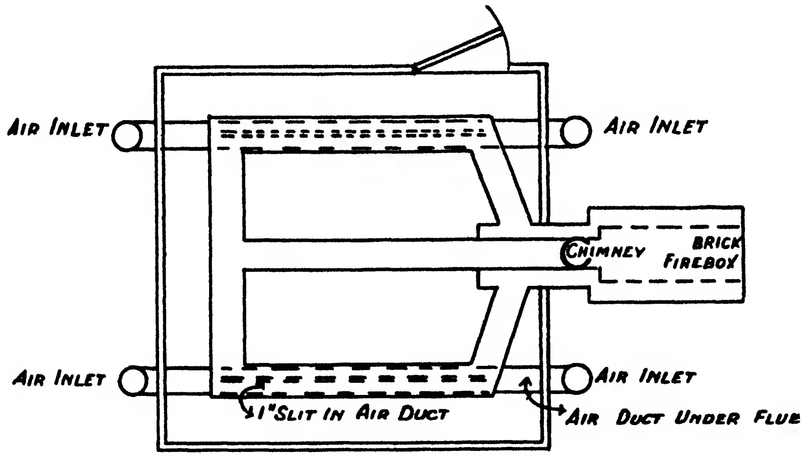
In order that proper control over these processes may be exercised it is necessary for the barn to be equipped with at least one thermometer and a hygrometer (wet and dry bulb thermometer). The latter indicates the humidity of the atmosphere in the barn. When the readings of the two columns are equal the atmosphere is fully saturated with moisture, and as the humidity decreases the difference between the readings becomes progressively greater, the wet bulb giving always the lower reading. Coloured spirit thermometers are preferable to those having a mercury column as they are more easily read at a distance or in a poor light.

YELLOWING.

Immediately the barn has been filled the door and all ventilators are closed and the fire lit. The temperature is raised to about 90 deg. F. and kept there. If the barn is well built and properly filled with freshly picked, unwilted leaf, the humidity will rise within an hour or so until there is a difference of not more than three degrees between the wet and dry bulb readings. This is due to the moisture transpired by the leaf.

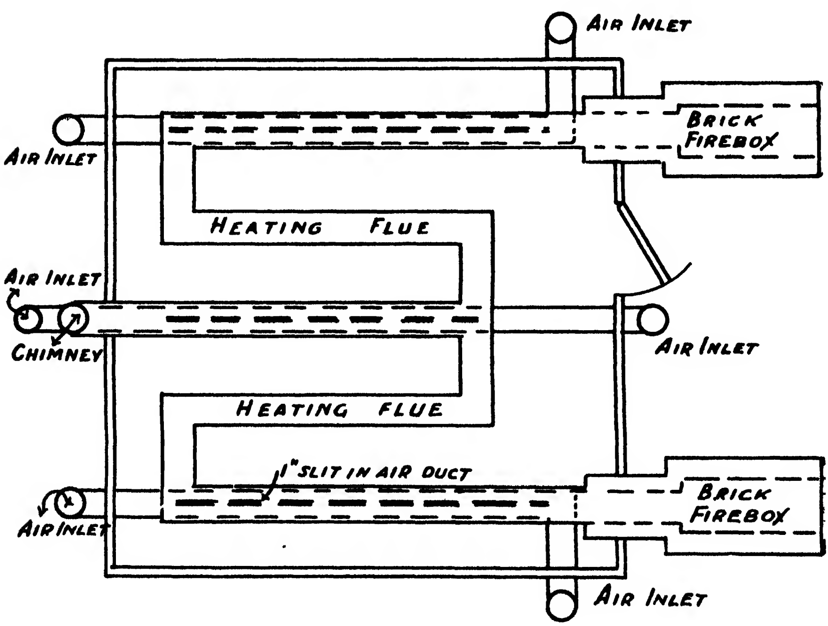
It frequently happens, however, particularly in the case of bag walled kilns, that this degree of humidity cannot be attained without the artificial introduction of moisture. This is usually done either by placing wet bags on the warm flues or by introducing low pressure steam from a boiler placed outside the barn.

The effect of the warm, humid conditions now obtaining in the barn is to greatly accelerate the ripening process which was begun before the leaf was picked. The rate at which yellowing takes place varies within wide limits according to the type of leaf being cured and the degree of maturity when picked. Anything from 12 to 48 hours or even longer may elapse before sufficient colour has developed to allow of the ventilators being opened and the second stage commenced. During this period, temperature may be very gradually raised to 100 deg., at which stage the wet bulb reading should be about 95 deg. or 96 deg. A knowledge of just how far yellowing should be allowed to proceed before commencing to fix the colour can be gained only by experience. Should fixing be commenced too early the leaf will cure out with a distinct green tinge to which the buyers object. On the other hand, should it be deferred too long, the bright yellow colour will turn to brown, with corresponding fall in the value of the finished article.



GROUND PLAN of 12' x 12' BARN

Fig 4



GROUND PLAN of 16' x 16' BARN

Fig 5

Figs. 4 and 5. Drawings showing ground plan of 12ft. x 12ft., and 16ft. x 16ft. tobacco-curing kilns, respectively. For description of kilns see text.

FIXING THE COLOUR.

It is at this stage that the ill-effects of bad picking become apparent. Fully mature leaf will now be quite yellow, that which was slightly less mature will still show a little green and really immature leaf will scarcely have begun to show any yellow at all. When the curer has decided that the major portion of the leaf is at the correct stage, the top and bottom ventilators are opened very slightly. Sometimes the top vent is opened an hour or two before the bottom ones with the idea that leaf which has reached the desired colour will commence to dry out, while that which still retains a tinge of green will be enabled to develop a little more colour.

Immediately on the opening of the ventilators, the humidity in the barn falls as will be shown by a gradually increasing difference between the wet and dry bulb readings. The most critical stage of the cure has now been reached. The object now is to gradually increase temperature and ventilation so that the web of the leaf is slowly dried out and killed as it reaches the desired bright yellow colour. At this stage the chemical changes taking place in the leaf cause moisture to be

Fig. 6.—Experimental Tobacco-curing Kiln and four other kilns embodying most of the characteristic features of the writer's design, but being constructed with bag walls, on the property of Mr. G. F. Combs, Jardee. (*Photo by Author.*)

expelled from the tissues, and conditions in the barn should be regulated so that a current of warm and comparatively dry air is continually passing over the surface of each leaf and absorbing this moisture as it is produced. Should insufficient ventilation be given, or the air allowed to become too cold, this moisture, instead of being carried away, will be deposited on the surface of the leaf and the condition known as "sponging" will occur. This is indicated by a brown discoloration on the surface of the leaf which will greatly reduce its value if allowed to go very far. Should the leaf show signs of sponging, temperature and ventilation should be increased. Should this be necessary, however, a certain amount of skill is required in the handling of the fire as a sudden increase of ventilation, particularly at night, is liable to cause a drop in temperature with the result that the condition may be made worse. On the other hand, too rapid raising of the temperature should be avoided as this tends to cause reddening of the leaf through scorching.

The drying of the web is indicated by the edges and tips of the leaves curling and becoming brittle, and this condition gradually spreads inwards towards the midrib. As drying proceeds temperature and ventilation are gradually increased

until, by the time the web is completely dry the thermometer is standing at about 135° and the ventilators are full open, both top and bottom.

DRYING OUT.

The colour has now been fixed and it only remains to dry out the thick, fleshy midribs. This is done by raising the temperature about 5° an hour and progressively decreasing ventilation until at 160° the ventilators are nearly closed. The temperature is held at this point until all midribs are quite dry and will snap without bending. Having made sure that there are no soft midribs, particularly in the corners of the barn nearest the door and in the top tier, the fires can be drawn and the door and vents opened wide to allow the leaf to cool down.

The period occupied during the cure will vary usually from three to five days according to the type of leaf, and it will be realised, of course, that someone must be in attendance at the barn during the whole of this time.

CONDITIONING.

On completion of the cure the leaf is absolutely dry and brittle and if handled in this condition it would fall to pieces. It is necessary, therefore, to allow it to re-absorb a certain amount of moisture from the atmosphere before it can be removed from the barn. Owing to the very dry, hot weather usually experienced in this State during the curing season, it is frequently necessary to artificially humidify the atmosphere of the barn, either by introducing low pressure steam or by warming up the flues again and placing wet bags on them. If steam is used great care must be taken not to overdo it. As the leaf "conditions" it loses its brittleness and becomes tough and pliable and in this condition it can be bulked down. A certain amount of experience is required to know just how much condition the leaf should have when bulked down. About 12 per cent. moisture content is the ideal to aim for, and this is indicated roughly by the "feel" of the leaf. It should emit a slight crackling when handled and the midrib should retain a certain amount of brittleness for about one-third of its length from the butt end.

If the leaf is bulked down too damp it will go mouldy and will be completely ruined. When bulked down in proper condition a mild fermentation takes place which results in a considerable improvement in both aroma and appearance of the leaf. If bulked too dry this fermentation is retarded and no such improvement takes place. The beginner, however, should err on the side of bulking too dry rather than run the risk of having his bulks go mouldy.

BULKING DOWN.

The tobacco should be bulked in a well-built shed preferably set on stumps at least two feet off the ground. Should the floor of the shed be at or near ground level it is advisable to erect a platform about two feet high and bulk the leaf on this in order to prevent absorption of moisture from the ground with consequent development of mould. The usual method of bulking is to make a stack about 3 or 4 feet wide and any desired length and height. The leaf is stacked with the butts to the outside, and as each cure is added it is usual to place two or three fairly heavy planks on top to consolidate the bulk and exclude air as much as possible. It is advisable also to cover the bulks closely with hessian as a protection against sunlight and, later on, against excessive absorption of moisture from the air after the Autumn rains have set in.

DESTRUCTION OF STALKS.

The grower should not consider the harvesting of his crop finished until the stalks of the plants remaining in the field have been pulled up by the roots and

burnt. If left growing, these plants act as hosts for a number of fungous diseases and insect pests, and a regulation under the Plant Diseases Act is in force to the effect that all such unharvested portions of the tobacco plant must be destroyed by burning by the end of May each year. If the plants are pulled up immediately the last of the leaf has been picked and are left lying on the ground for a few weeks during the dry, hot weather usually experienced during March, little difficulty will be encountered in getting them burnt. Should this operation be delayed until the rains have set in in April, however, it will be very much more difficult to accomplish.

A Review.

INSECTS OF CITRUS AND OTHER SUB-TROPICAL FRUITS.

By HENRY J. QUALE.

(Pp. VII. and 583 with 377 figures. Ithaca, New York Comstock Publishing Company Inc., 1938. Price 5 dollars.)

H. J. Quale is Professor of Entomology in the University of California and Entomologist in the University of California Citrus Experimental Station. Therefore he is well qualified to deal with the problems which he has so ably treated in his recent volume.

The book primarily deals with the citrus pests of the United States of America, but Professor Quale's experience in various of the important citrus growing sections of the world enables him to include all the chief centres in his discussion.

In addition to citrus pests the author deals with the insects and mites attacking such sub-tropical fruits as the Vinifera grape, Persian walnut, almond, pecan, fig, olive, oriental persimmon, date and pomegranate. Much practical as well as purely scientific material is contained in the 583 pages and the book should prove equally valuable to orchardists, students, and entomologists.

Of the insects mentioned those of chief interest to Western Australian readers would be the Red Scale (*Aonidiella aurantii*), the Black Citrus Aphis (*Toxoptera aurantii*), the Orange Rust Mite (*Phyllocoptes oleivorus*), the Fruit Fly (*Ceratitis capitata*), the Black Scale (*Saisettia oleae*), the Brown Scale (*Coccus hesperidum*), and the Orange Piercing Moth (*Othreis materna*).

Red Scale (*Aonidiella aurantii Maskell*) is undoubtedly the most serious citrus pest found in Australia and a very comprehensive account of this insect as it occurs in various parts of the world is given.

Two extremely useful chapters on fumigation and spraying will be found at the end of the book and they are well worth attention.

A historical account of fumigation treatment is given, together with an exhaustive discussion upon fumigation injury and the responsible factors.

Professor Quale has always taken a keen interest in biological methods of control and a special chapter deals with this topic. Of interest to growers in this State is the control of Red Scale by the wasp Aphitis chrysomphali and the subjection of Black Scale by three parasites, *Metaphycus loundsburyi* and *Tomocera californica* and *Scutellista cyanea.*

In conclusion it must be said that Professor Quale has dealt very capably with a very difficult subject and his book is one which no citrus grower or entomologist can afford to neglect.

(C. F. H. Jenkins.)

WESTERN AUSTRALIAN EXPORT LAMBS, 1937.

J. E. NICHOLS, F. L. SHIER, AND R. P. ROBERTS.

The export of frozen lamb from Western Australia to the United Kingdom commenced in 1906 with the shipment of an experimental consignment of 422 carcases by the R.M.S. "Brittania." The lambs, which were forwarded by the W.A. Producers' Union Ltd., were drawn from the Wagin, Beverley and Toodyay districts.

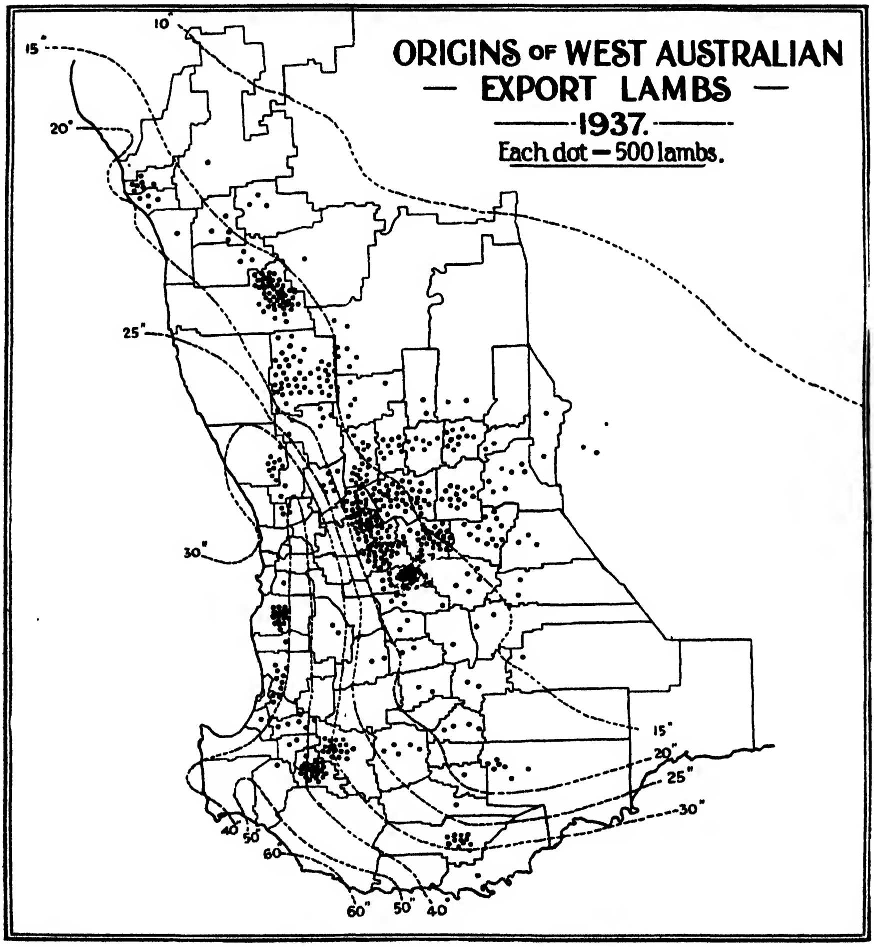


Fig. 1.

They reached London in excellent condition and realised up to 6¾d. per lb. The export trade expanded rapidly in the next two or three seasons, largely under the stimulus of the relatively low prices then being received for wheat. However, between 1914 and 1929 the trade declined and it was not until 1930 that regular shipments recommenced. The progress since that date is shown by figures obtained from the Government Statistician and summarised in Table 1.

TABLE 1.

NUMBER OF LAMBS EXPORTED FROM WESTERN AUSTRALIA, 1930–1937, TOGETHER WITH AVERAGE PRICES PER HEAD.

Year.	No. of carcases.	F.O.B. Value per carcase (excluding skin, by-products, etc.). s. d.
1930	22,826	...
1931	63,189	16 2
1932	10,527	13 10
1933	39,513	11 11
1934	113,454	17 5
1935	168,201	16 4
1936	143,949	17 0
1937	269,260	17 4

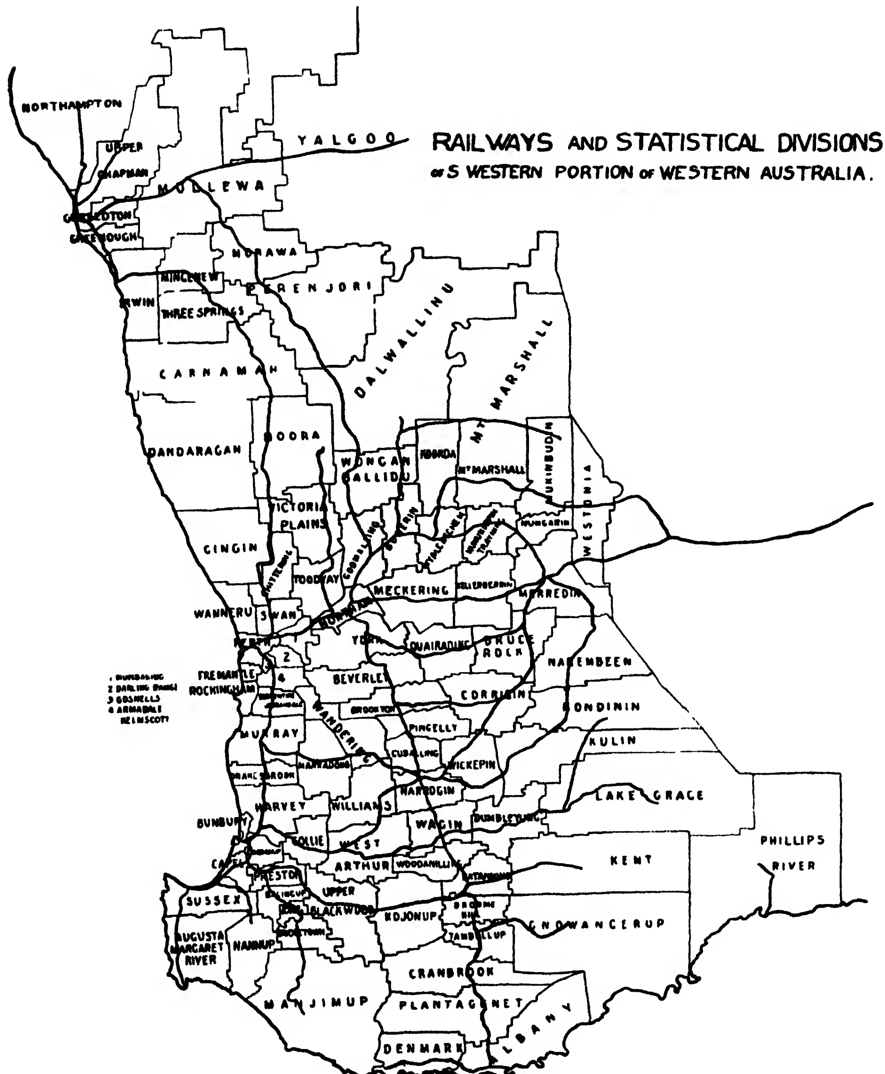


Fig. 2.

This rapid expansion of production since 1929 can be ascribed to the relatively attractive prices which have been maintained for lamb, as compared with those for wheat and merino wool, and to the existence in W.A. of considerable areas favourably situated for lamb raising. The extension of the subterranean clover belt is also becoming of increasing importance in the expansion of the lamb industry.

In the agricultural districts of Western Australia there is a well defined seasonal change from cool wet winter to hot dry summer, and the farming practices necessitated by those climatic conditions are also favourable to the incorporation of lamb production. The lambs are dropped in the autumn and leave the farm in the late winter and spring, so that the greatest numbers of sheep are carried during the months when there is usually plenty of green feed available.

The lambs available for export each year are influenced in both quantity and quality by seasonal conditions. The best years are those in which the pastures and fodder crops germinate early in the autumn, and do not receive any subsequent set-back by dry weather. Early rains are very valuable provided they are not immediately followed by dry hot weather which kills the young plants, giving rise to conditions even worse than when the germinating rains do not eventuate until the end of May or early June.

For the first four or five years after export had recommenced in 1930 the percentage of first-grade lambs produced each year was a reasonably good indication of the type of season which had been experienced in the lamb producing districts, but in recent years production has been extending over a much greater area, so that caution must be exercised when attempting to draw conclusions from figures which give averages for the producing districts of the whole State.

In comparing figures for percentages of grades exported account has also to be taken of the effects of supplies in other States and the demands of local consumption. For instance, the standard of lamb bought by exporters locally is likely to be affected by the extent to which their total requirements can be met from other States.

The yearly grading figures for the period 1930-37 are given in Table 2—

TABLE 2.

GRADING OF WEST AUSTRALIAN EXPORT LAMBS, 1930-37.

Year.	Firsts.	Seconds.	Thirds.	Rejects.
1930	33·0	36·7	20·0	10·3
1931	34·5	44·4	18·0	3·1
1932	51·7	26·3	17·6	4·4
1933	37·8	22·1	37·2	2·9
1934	51·8	24·6	21·1	2·5
1935	38·3	38·4	21·5	1·8
1936	26·9	38·9	30·9	3·3
1937	32·0	37·2	27·7	3·1

While the good seasons of 1932 and 1934 are directly expressed in this table by the high percentage of first-grade carcases, the precise effects of varying seasonal conditions on the grading of one year's lambs as a whole cannot be suggested without further studies. So far this necessarily detailed type of investigation has been made only for one year, i.e., 1937, an account of which is given here. The authors have made no attempt to forecast the future economic position of the industry in the light of possible future demand and potential supply, but have confined themselves mainly to an analysis of the available figures of the lambs treated for export in Western Australia in 1937. It is hoped to make similar studies in subsequent years.

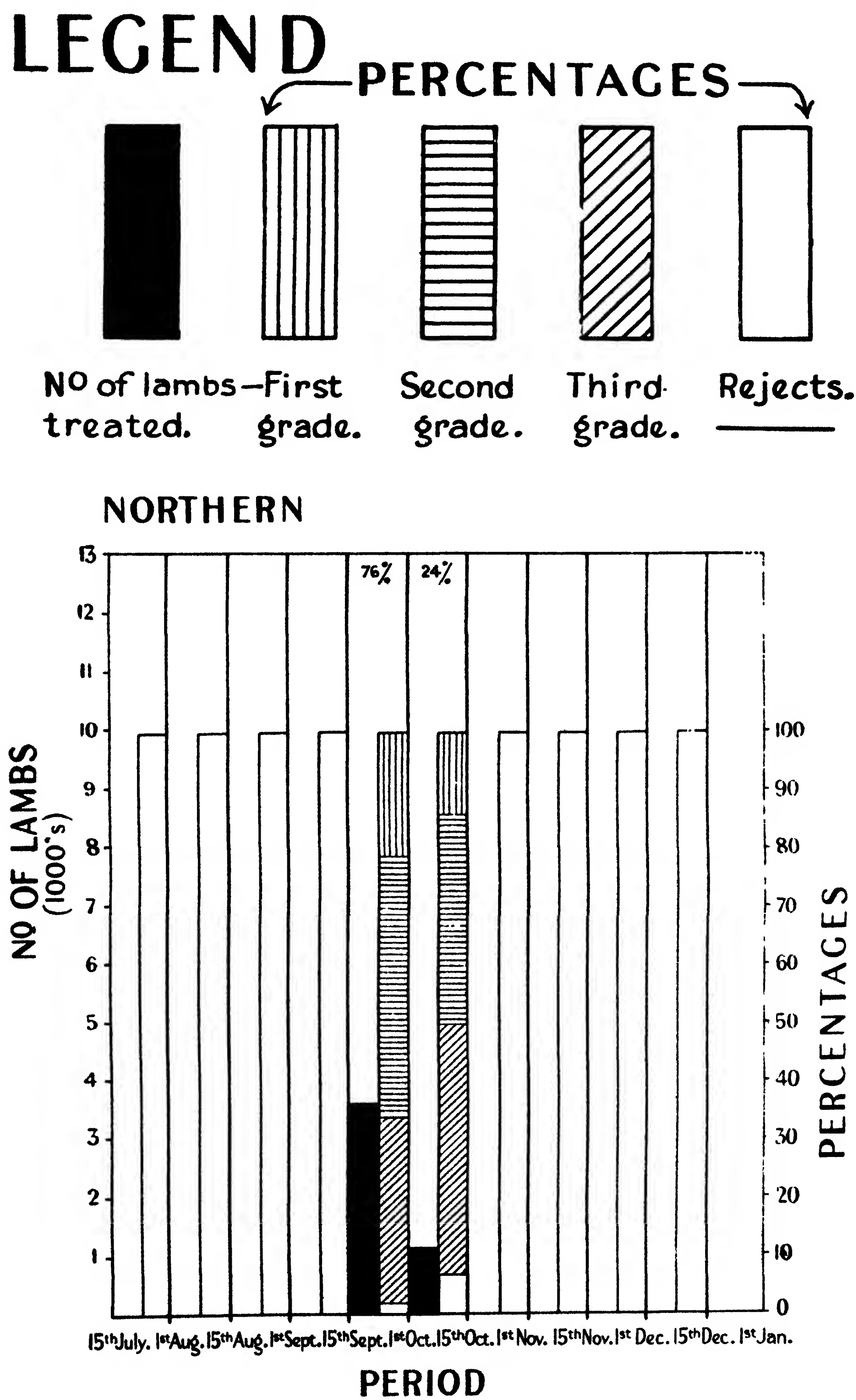
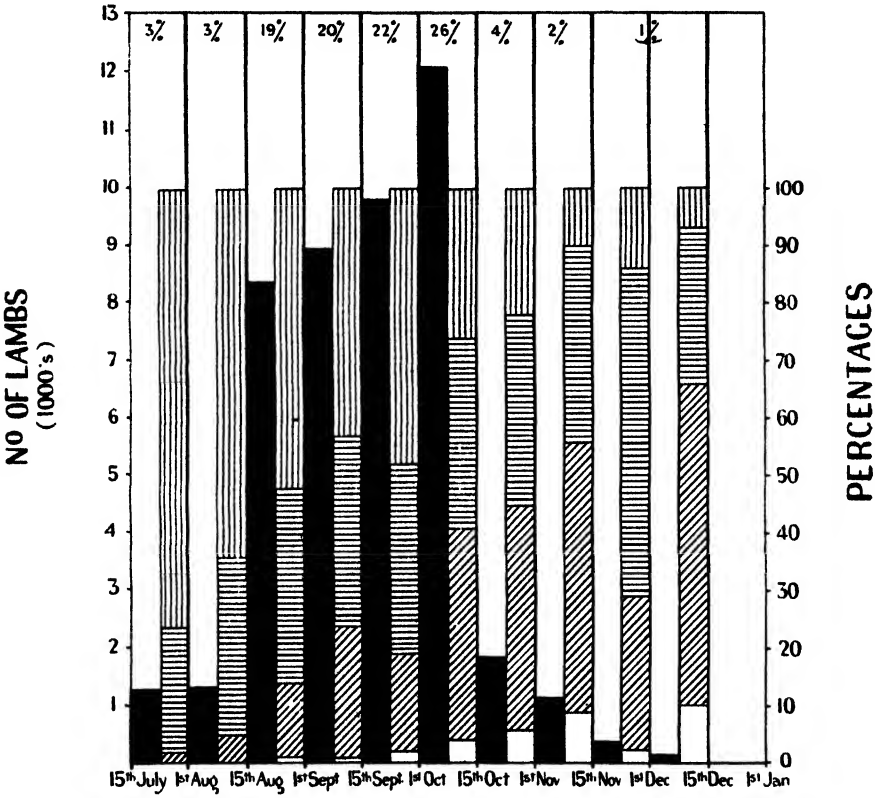

LEGEND
PERCENTAGES
No of lambs treated.
First grade.
Second grade.
Third grade.
Rejects.
NORTHERN
76%
24%
No OF LAMBS (1000's)
PERCENTAGES
15th July. 1st Aug. 15th Aug. 1st Sept. 15th Sept. 1st Oct. 15th Oct. 1st Nov. 15th Nov. 1st Dec. 15th Dec. 1st Jan.
PERIOD

Fig. 3.

Grading at all treatment works throughout Australia is under the control of the Commonwealth Department of Commerce and officers of that Department make periodical visits to the different works to see that a uniform standard is maintained.

The statistical information available for Western Australia is well suited to an analysis of this type, as there is no interstate movement of lambs for export; all the lambs treated for export pass either through the W.A. Meat Export Works at Robb's Jetty, Fremantle, or the Albany Freezing Works at Albany.

MIDLANDS



PERIOD

Fig. 4.

There are several ways in which the farmer may dispose of his lambs when they are ready for export. He may consign them to London agents, in which case they are forwarded to the works, where all arrangements are made for handling, shipping, insurance, etc., etc. The farmer receives the actual London returns, plus skin values and caul fat, less handling charges, freight and commission, due allowance being made for exchange.

A second method is that of selling on the farm to one of the meat exporting firms on the basis of so much per head, or on a poundage basis on the outturn at the works. Owing to the keen competition for lambs, following the entry into the

market since 1936 of some of the large meat exporting companies, this is now probably the most popular way of disposing of the lambs.

Where sufficient lambs have been available at a particular time, country auction sales have been arranged at some centres. This system has advantages for the producer, but is unsatisfactory to the buyers and agents unless a large yarding is available.

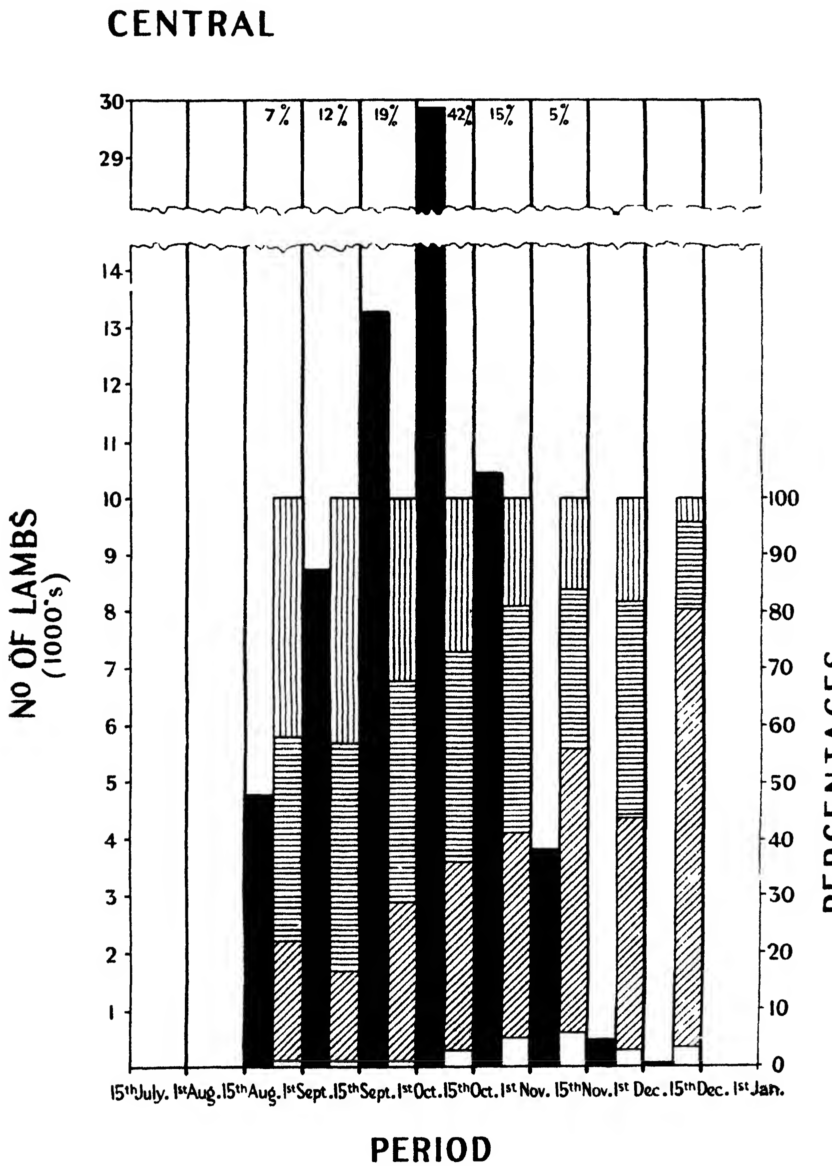


Fig. 5.

A fourth method of disposing of the lambs is to forward them to the weekly Metropolitan markets at Midland Junction. Here they may be bought for the local trade or taken by the meat buying companies for export purposes. During

the 1937 season approximately 276,000 lambs were treated at the export works at Robb's Jetty and Albany, of which 69,000 were obtained through the Midland Junction markets.

After slaughter and dressing, and before passing to the freezers, the lambs are examined by the meat inspectors and are either rejected or passed as fit for export. The carcases are next weighed and graded and these particulars recorded. As the main feature of this study is an analysis of grading statistics, it is important that the significance of the grades should be appreciated.

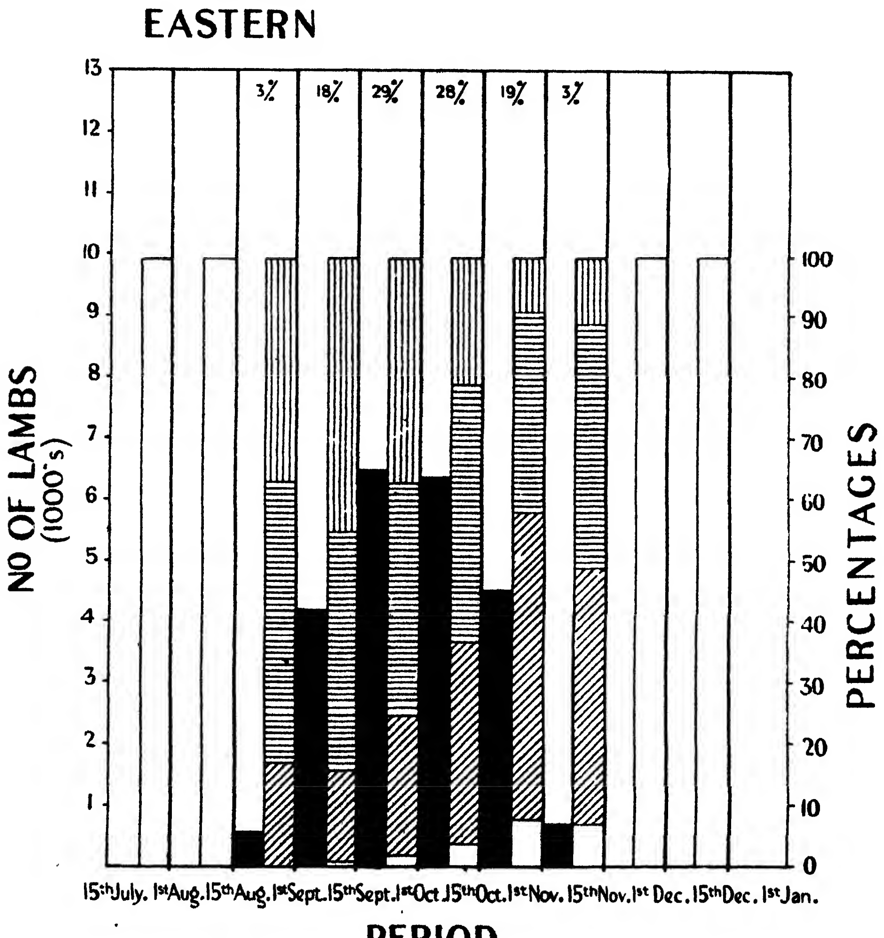


Fig. 6.

The three grades discussed in this paper are described in the Commonwealth Regulations as follows:—

"First Quality.—Carcases shall be of reasonably good conformation, with well developed loins, legs and shoulders, good bloom and attractive appearance. The external covering of fat must extend evenly over the loins, back, shoulders and legs. Carcases showing defective covering of the loins or back not to be graded as first quality. The internal fatty covering of the loin and kidneys to be well developed, but excessive internal fat is not necessary.

Second Quality.—Carcases to be of reasonably good conformation, with well developed loins, legs and shoulders, good bloom and appearance. The external covering of fat to extend over the loins, back, shoulders and legs, but not necessarily completely covering the underlying muscle of the loins and back. Greater latitude to be allowed in the fatty covering of the shoulders and legs than in the case of first quality lambs. Internal fatty covering of the loin and kidneys to be reasonably well developed.

Third Quality.—This quality grade includes carcases which in conformation and development of the loins, legs and shoulders, do not comply with the requirements of second-quality. The bloom and general appear-

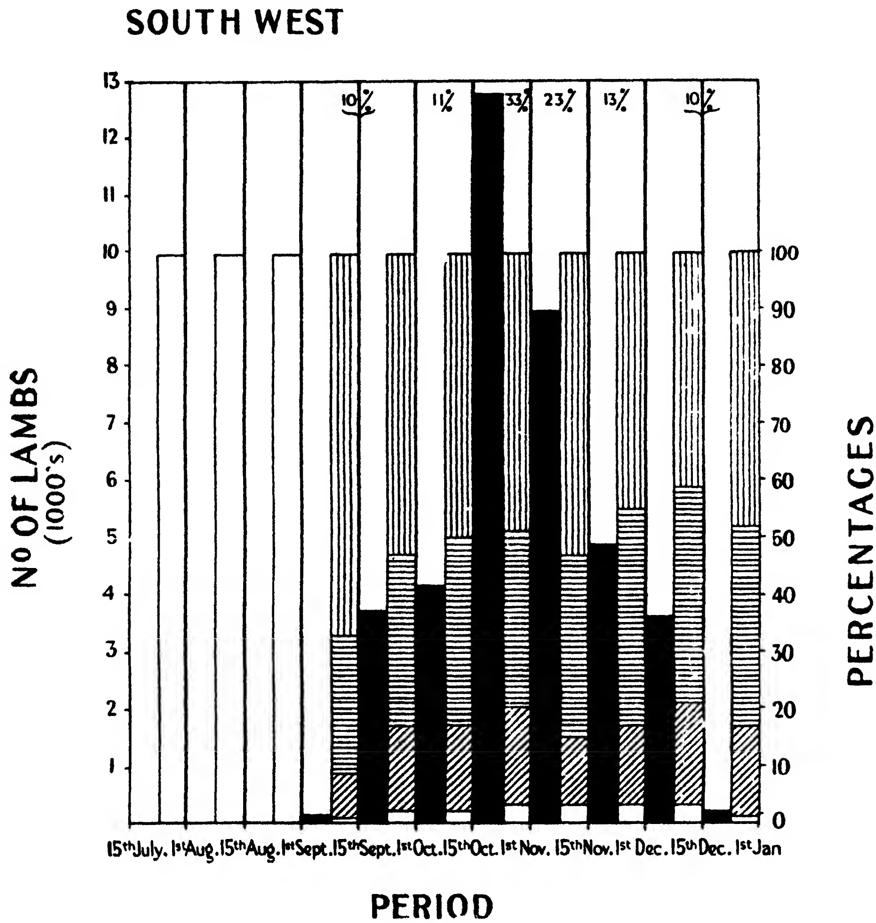


Fig. 7.

ance not so attractive and the external covering of fat on the back and loins defective. Carcases, however, which do not possess a sufficient covering of fat over the back and loins to protect the underlying muscle during the process of freezing and of storage and transport are not to be included and are to be rejected for export. Internal fatty covering of the loins and kidneys lightly developed, but must be firm in texture."

In addition, some exporters have the "down" lambs graded out separately. As well as conforming to the general standards laid down for first-grade lambs

they must possess the compact nuggety conformation typical of the British "down" breeds. However, as this practice is not adopted by all exporters, and the number of lambs which are so graded is small, this grade has not been considered here, all "down" lambs being included in the first-grade.

The chief reasons for rejection of lambs for export are bruising, grass seed injury, disease, dressing, unsuitable carcase colour and poor finish which renders them unsuitable for freezing.

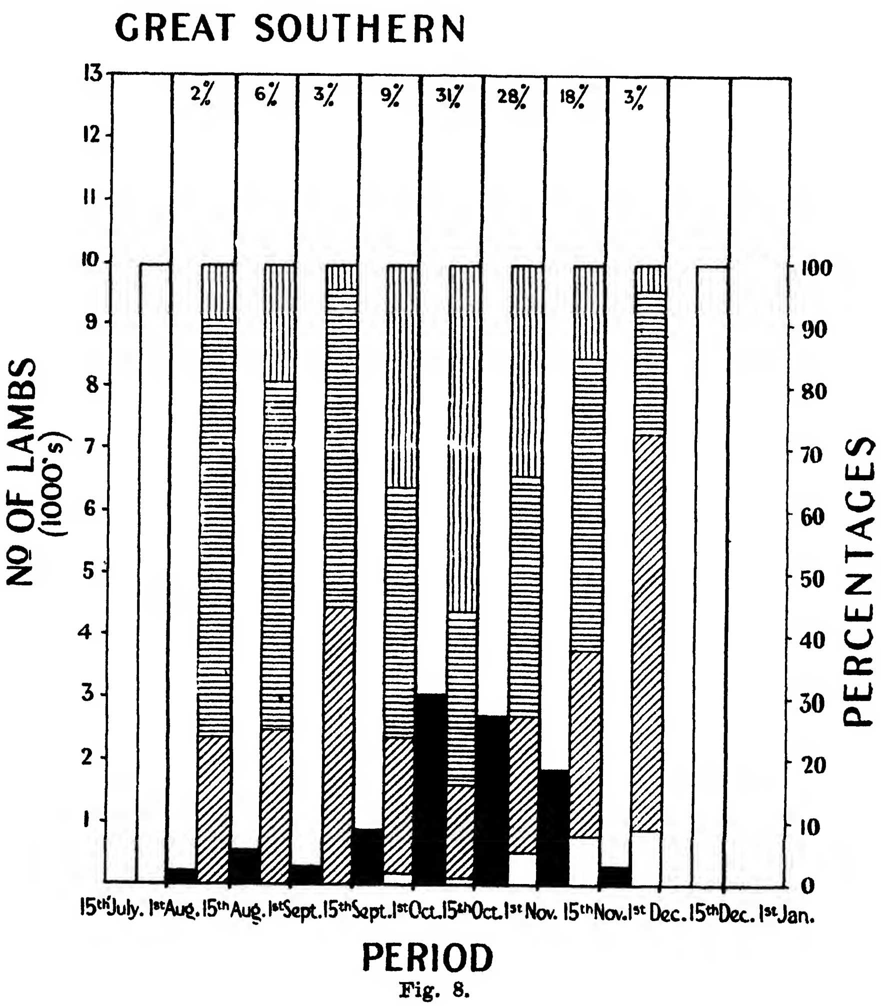


Fig. 8.

The statistics which were available concerning the lambs treated for export in the 1937 season can be divided into two groups consisting of—

(a) information relating to the railway centre from which consigned, date of arrival at freezing works, number and weight of lambs in the different grades, of individual consignments of lambs totalling approximately 207,000. Of this number about 178,000 passed through the W.A. Meat Export Company's works at Robb's Jetty and the remainder through the Albany Freezing Works:

(b) information concerning the origins of 69,000 lambs which were sold in the Midland Junction markets to the meat exporters. After passing through this central market the individual consignments lost their geographical identity and grading figures could not be obtained.

The districts of origin of the total 276,000 lambs are shown diagramatically in Figure 1, while Figure 2, showing railways, road board districts, etc., has been included as a key.

For the purpose of this study all the lamb producing areas to the east of the 15in. rainfall line are grouped together and referred to as the Eastern districts. To the west of this line Mingenew and other road board districts northwards are referred to as the Northern districts. Three Springs, Carnamah, Moora, Dandarragan and the northern portion of Victoria Plains constitute the Midlands. The Central district includes Gingin, Chittering, Swan, Toodyay, Northam, York, Beverley, Brookton and those parts of Goomalling, Meckering and Quairading to the west of the 15in. isohyet. The South-West consists of all road board districts to the west of the 25in. rainfall line south of Perth and extending east as far as the east boundaries of the Upper Blackwood and Manjimup districts. The Great Southern district lies between the 15in. and 25in. rainfall line south of Brookton and Quairading and north of Katanning and Kent. The Kojonup, Cranbrook, Plantagenet, Denmark, Albany, Gnowangerup, Tambellup, Broomehill, Katanning and Kent districts constitute the Lower Great Southern.

These seven zones or districts contributed to the total 275,963 lambs treated for export in the proportions set out in Table 3.

TABLE 3.

LAMBS TREATED FOR EXPORT ACCORDING TO DISTRICTS OF ORIGIN.

District.	Lambs for which complete grading information was available (207,000). Per cent.	Lambs for which complete grading information was not available (68,963). Per cent.	Total lambs treated (275,963). Per cent.	No.
Northern	2	1	2	5,207
Midlands	22	12	19	53,218
Central	34	45	37	102,404
Eastern	11	32	16	45,327
South-West	19	3	15	41,024
Great Southern	5	6	5	14,137
Lower Great Southern ...	7	1	6	14,646
Totals	100	100	100	275,963

The percentage distribution of the 68,963 lambs which passed through the Midland markets, and for which complete grading information was not available, is shown in the second column of Table 3. It will be seen that the proportions of the lambs coming from the different districts are not precisely the same as those for which complete grading figures were available. They were distributed in such a way as to reduce the percentage contributions of the Midland and South-West lambs in the total averages and increase those of the Central and Eastern districts. This has to be remembered when drawing conclusions for the State as a whole on the basis of the 207,000 lambs for which complete information was obtained.

The contributions of the different districts to the lambs received at the works during half-monthly periods throughout the killing season are shown in Table 4 These figures refer to the 207,000 lambs mentioned previously.

TABLE 4.

CONTRIBUTIONS OF DISTRICTS TO LAMBS RECEIVED AT WORKS DURING HALF-MONTHLY PERIODS.

District.	Per cent. for—										
	16th–31st July.	1st–15th Aug.	16th–31st Aug.	1st–15th Sept.	16th–30th Sept.	1st–15th Oct.	16th–31st Oct.	1st–15th Nov.	16th–30th Nov.	1st–15th Dec.	16th–31st Dec.
Northern	...	...	...	...	9	2	...	...	...	...	...
Midlands	100	84	59	38	24	21	5	6	5	3	...
Central	...	3	33	37	33	51	29	19	6	2	...
Eastern	...	...	4	18	16	11	13	4	...	...	...
South-West	...	...	...	1	9	7	36	45	72	70	100
Great Southern ...	...	13	4	1	2	5	8	9	5	...	...
Lower Great Southern ...	...	...	...	5	7	3	9	17	12	25	...
Total (per cent.) ...	100	100	100	100	100	100	100	100	100	100	100
Total (No.) ...	1,265	1,595	14,322	23,450	40,511	58,362	35,394	19,885	6,815	5,195	206

In Table 5 the gradings of the 1937 lambs are given according to districts.

TABLE 5.

GRADING OF WESTERN AUSTRALIAN EXPORT LAMBS ACCORDING TO DISTRICT OF ORIGIN, 1937.

District.	Firsts.	Seconds.	Thirds.	Rejects.
Northern	19·5	42·5	34·5	3·5
Midlands	40·5	33·2	23·8	2·5
Central	28·7	37·7	30·7	2·9
Eastern	27·3	38·7	30·2	3·8
South-West	49·2	32·9	15·1	2·8
Great Southern	34·3	38·4	23·3	4·0
Lower Great Southern ...	54·4	34·9	8·8	1·9
State	32·0	37·2	27·7	3·1

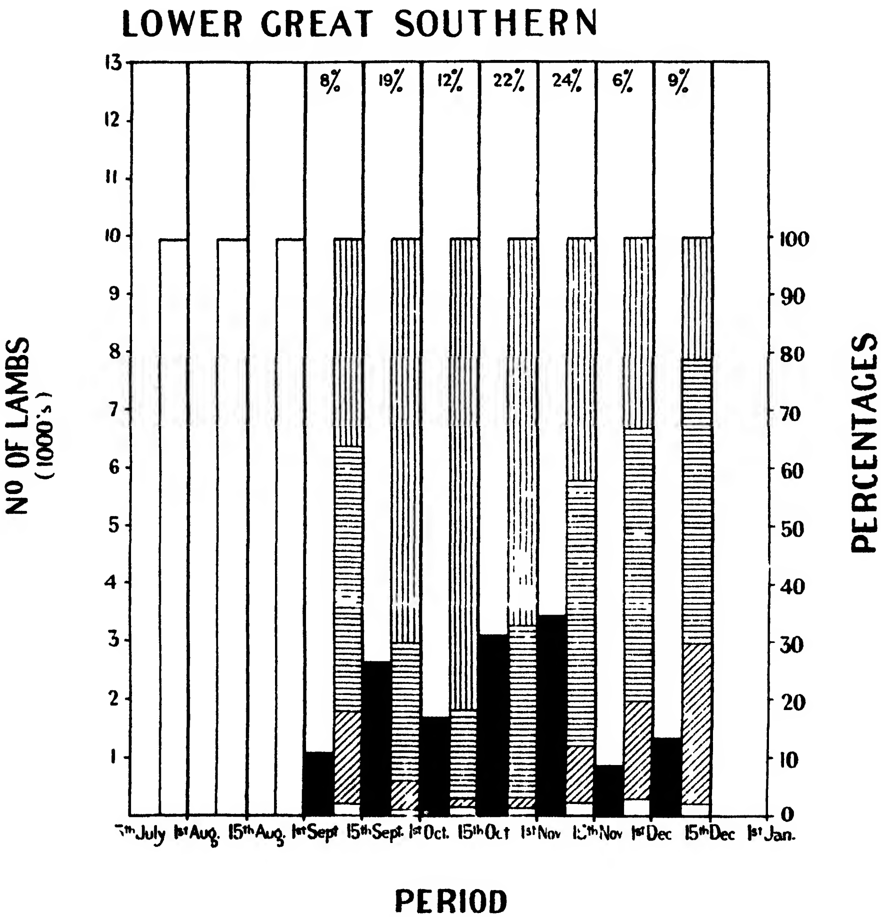


Fig. 9.

In Figures 3-9 are shown for each district—

(1) The total numbers of lambs received for export at the freezing works during half monthly periods (in black), and

(2) The percentage grading figures for each of these periods (hachuring).

In connection with all the figures used to make comparisons between districts, it must be borne in mind that lamb production in three of them, i.e., Great Southern, Lower Great Southern and Northern, is, as yet, relatively small, and that the numbers of lambs from these districts are too few to allow of any very definite conclusions to be drawn concerning them. All three of them are likely to expand their production rapidly in the next few years should there be no radical alteration in the economic position of the industry.

A study of the graphs for the main producing districts reveals a number of interesting points, perhaps the most noticeable of which is the rapid falling off in quality of lambs from the lower rainfall districts as the season advances. In the South-West and Lower Great Southern, on the other hand, which enjoy a heavier rainfall, the quality was fairly well maintained throughout the season. In the Midland and Northern districts the winter rains usually commence at about the same time as in the Central, Eastern and Great Southern districts, but as winter temperatures are somewhat milder, growth of crops and pastures is rather more rapid, particularly in the early spring. In the South-West and Lower Great Southern, on the other hand, the rainy season is longer and the rains heavier than in the Midlands, but winter growth is very slow during the association of low temperatures, excess water and insufficient sunshine. It is not until the advent of warmer weather in September and October that the flush period for feed commences. The transition from winter to summer feed conditions becomes of increasingly shorter duration as one goes north or east.

It would be anticipated, therefore, that the Midlands would produce the main bulk of its lambs rather earlier, and the South-West and Lower Great Southern rather later than would the Central and Eastern districts.

The data presented show that this actually was the case in 1937. In the latter part of July and the first half of August the Midlands provided the bulk of the lambs marketed. Lambs from the Central districts began to come in in quantities in the latter part of August, but did not reach their maximum until the first half of October, the peak period of activity, in which they constituted 51 per cent. of the total receivals.

Up to the middle of October contributions from the South-West were relatively unimportant, but after that date to the finish of the season in December the South-West supplied a steadily increasing percentage of the receivals.

Seasonal effects in the various districts are also apparent in the grading figures. Where the season is short the lambs grade well in the early part, but fall away badly towards the end. In the South-West and Lower Great Southern, with their longer growing season, finishing and marketing, can be extended over a longer period.

The areas lying outside the 15in. rainfall line, which have been designated the Eastern districts, are not generally regarded as suitable for fat lamb production, and in 1937 from this extensive area only 45,000 lambs were treated for export. The season was not a favourable one in these districts, yet the quality of the lambs forwarded for export was little below that of the Central districts' lambs. The reasons for this situation cannot be directly advanced on the basis of one year's information.

Summary.

An analysis of available statistics of lambs treated for export in Western Australia during the 1937 season is presented.

The statistics concerning grading etc., were analysed on a district basis and comparative figures obtained for seven districts with respect to fluctuations in numbers of lambs coming forward and quality of carcases throughout the export period.

The bulk of production is at present from the Central, Midlands, Eastern and South-West districts.

The season commenced towards the end of July and finished at the end of December, with a period of maximum activity from the middle of September to the end of October.

The effect of seasonal conditions in the main districts on quality and time of delivery is briefly discussed.

The authors wish to acknowledge their indebtedness to the many people and organisations who gave assistance in the preparation of this paper. Without the ready co-operation of the W.A. Meat Export Company and the Albany Freezing Works, whose officers were responsible for the compilation of the whole of the details concerning grading of individual consignments of lambs, the study could not have been undertaken. Messrs. Elder, Smith and Company; Dalgety and Company; Goldsbrough Mort and Company, and The Westralian Farmers Ltd., supplied statistical information relating to those lambs which were sold through the Midland Junction saleyards. Lands Department draftsmen compiled the block diagrams —Figs. 3 to 9. Helpful criticism and advice came from Mr. A. M. Stewart, of the Institute of Agriculture, and Mr. N. Davenport, of the Department of Agriculture. To all these people the authors extend their thanks.

THE COST OF FEEDING PURE BRED DAIRY COWS UNDER THE AUSTRALIAN OFFICIAL HERD RECORDING SCHEME.

Western Australia, 1937-8.

G. K. Baron-Hay, Superintendent of Dairying.

G. Slater.

This article, which is compiled annually from figures obtained in connection with the Pure Breeds Herd Recording Scheme, is published as an indication to breeders of how wide is the range of feeding costs, and in the hope that the information may assist in reducing the average cost of feeding by a judicious use of pasture, succulent conserved fodder, and, wherever possible, home-grown crops.

As the herds included are dotted over the whole area of the South-West and extend as far north as Geraldton and west to Doodlakine, naturally the climatic conditions will vary greatly, as will the costs of producing home-grown fodders. For this reason the average wholesale market price for the various concentrates has been used so that a more true comparison of the husbandry may be made.

It is not intended that these tables should figure in the nature of a competition, consequently the owners' names have been replaced by a herd letter. Any breeder, however, may obtain the identification of his herd by applying to the Department of Agriculture.

Table I. sets out the prices of the feeding stuffs used in arriving at these costs.

TABLE 1.

PRICES USED IN VALUATING THE FOODSTUFFS CONSUMED DURING THE YEAR ENDED 30TH JUNE, 1938.

	£	s.	d.
Chaff (per ton) ...	5	0	0
Wheat, crushed (per bushel) ...	0	4	11
Oats ...	0	2	7
Bran (per bushel) ...	0	1	4
Pollard (per bushel) ...	0	1	4
Silage (per ton) ...	0	10	0
Meggitt's Meal (per ton) ...	17	7	0
Proteena (per ton) ...	12	0	0
Cowmeal (per ton) ...	15	3	0
Keymeal (per ton) ...	12	0	0
Halmeg (per ton) ...	14	11	0
Brewer's Grains (per bushel) ...	0	0	5
Green Lucerne (per ton) ...	1	0	0
Green Maize, Sudan Grass and Cereal Crops—			
Chaffed (per ton) ...	0	15	0
Grazed (per head per week) ...	0	2	6
Meadow Hay (per ton) ...	3	0	0
Pasture (per head per week)—			
Good, green ...	0	2	6
Dry ...	0	1	6

Table II. shows the average results over the past 15 years. The slight drop in average butter-fat production probably is due to the inclusion in the Scheme of three newly formed herds.

TABLE 2.

PURE-BRED COWS UNDER OFFICIAL TEST—AVERAGE RESULTS OVER A PERIOD OF 15 YEARS.

Year ended 30th June.	Average Milk Yield per Cow.	Average Butter-fat per Cow.	Average Cost of Feed per Cow.	Average Cost of Feed to Produce 1lb Butter.	Average Cost of Feed to Produce 1 gall. Milk.	Average Price, Butter-fat per lb.
	galls.	lbs.	£ s. d.	pence.	pence.	pence.
1924 ...	600	319·50	10 4 10	7·70	4·09	19·5
1925 ...	652	308·59	14 13 2	10·77	6·15	17·5
1926 ...	624	312·01	14 14 7	11·15	5·66	19·0
1927 ...	602	290·72	14 10 5	12·00	5·79	19·0
1928 ...	592	280·56	15 11 4	13·34	6·34	19·5
1929 ...	629	295·10	15 1 0	12·24	5·74	20·0
1930 ...	636	294·98	14 10 3	12·74	5·10	19·5
1931 ...	643	301·60	9 14 7	7·74	3·64	16·0
1932 ...	696	318·96	10 18 3	8·21	3·76	14·0
1933 ...	664	308·60	9 2 3	7·08	3·29	11·0
1934 ...	720	333·70	10 2 6	7·28	3·37	10·0
1935 ...	682	326·61	9 18 0	7·34	3·49	12·5
1936 ...	681	320·14	8 14 7	6·54	3·08	12·5
1937 ...	685	309·31	11 5 1	8·73	3·94	14·5
1938 ...	664	306·99	10 19 7	8·58	3·97	15·0

Although the Jersey herds in Table III. show the lowest cost of production, the yields of milk and butter-fat are considerably below the average shown in Table II., and figures throughout indicate that in several of these herds the cows

are underfed, the owners relying solely on inadequate pasture without supplementing with silage or concentrates for maximum production. The market for young bulls ex comparatively low-producing dams is very limited and this aspect should receive the careful consideration of breeders.

Table 3.

BREEDS COMPARED AS PRODUCERS OF MILK AND BUTTER-FAT.

Breed.	Average Yield of Milk per Cow during 9 months.	Average Test.	Average Yield of Butter-fat per Cow during 9 months.	Average Cost of Feed per Cow.	Average Cost of Feed to produce 1 gall. Milk.	Average Cost of Feed to produce 1lb. Butter-fat.
	lb.		lb.	£ s. d.	pence.	pence.
Guernsey (7 herds) ...	6,187	5·23	321·93	11 6 9	4·39	8·45
A.I.S. (10 herds) ...	7,492	4·03	301·73	13 1 9	4·19	10·41
Jersey (10 herds) ...	5,584	5·24	292·59	7 17 1	3·38	6·44

This is the first occasion since the commencement of these articles on which the production of herds in the "Dry" areas has exceeded that of herds in the "Wet." This appears to bear out the statement made above that unless pasture is properly managed by renovating, top dressing and rotational grazing, it must be supplemented with concentrates.

Table 4.

COST IN LIGHT RAINFALL AREAS COMPARED WITH THE SOUTH-WEST.

Average.	Production.		Cost of Feed for—	
	Milk.	Butter-fat.	1 gall. Milk.	1lb. Butter-fat.
	lb.	lb.	pence.	pence.
Dry Areas (13 herds) ...	7,260	313·45	4·43	10·27
Wet Areas (14 herds) ...	5,834	293·13	3·45	6·86

Last year Mr. C. J. Cunningham's herd occupied second position in the table showing herds in order of merit as profitable butter-fat producers, and this year, although his cost of feeding has increased slightly, his herd shows as the most profitable of the 27 under review. This consistency indicates Mr. Cunningham's excellent judgment, both in breeding and feeding, as it will be noted that although his costs are lower than the average, production has not suffered. The owner of the herd at the other end of the table, owing to the situation of his holding, is in the unfortunate position of having to purchase no less than 80 per cent. of his feed and grazing is confined to poor natural grasses through a few months only of the year.

In computing the available skim milk, it is assumed that the calf consumes 60 gallons of whole milk, 10 per cent. of the milk goes with the cream, and a further 120 gallons of skim milk is fed to the calf.

TABLE 5.

HERDS IN ORDER OF MERIT AS PROFITABLE BUTTER-FAT PRODUCERS.

Place.	Herd.	District (W = Wet, D = Dry).	Breed.	Average Butter-fat per Cow for 9 months.	Available Skim Milk per Cow.	Value of Butter-fat at 1s. 3d. lb.	Value of Skim Milk at 1d. per gall.	Gross Return from Butter-fat and Skim Milk.	Cost of Feed per Cow for 9 months.	Profit per Cow.	Cost of Feed to produce 1lb. Butter-fat.
				lb.	lb.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	pence.
1	W	W	Jersey	363·64	3,838	22 14 7	1 12 0	24 6 7	8 7 2	15 19 5	5·52
2	S	W	do.	329·06	4,123	20 11 3	1 14 4	22 5 7	6 10 3	15 15 4	4·75
3	E	W	do.	296·21	3,407	18 10 3	1 8 5	19 18 8	4 10 0	15 8 8	3·64
4	M	D	Guernsey	435·41	5,361	27 4 4	2 4 9	29 9 1	14 10 2	14 18 11	8·00
5	AC	W	A.I.S.	333·09	5,887	20 16 3	2 9 1	23 5 4	8 14 2	14 11 2	6·27
6	Z	D	do.	374·60	6,550	23 8 3	2 14 7	26 2 10	12 9 10	13 13 0	8·74
7	U	W	Guernsey	303·35	3,575	18 19 2	1 9 10	20 9 0	7 5 2	13 3 10	5·74
8	D	W	do.	331·06	4,959	20 13 9	2 1 4	22 15 1	9 15 4	12 19 9	7·08
9	I	D	Jersey	339·61	3,925	21 4 5	1 12 10	22 7	10 0 3	12 17 0	7·08
10	B	W	do.	245·88	2,726	15 7 4	1 2 9	16 10 1	5 0 5	11 9 8	4·90
11	K	W	do.	277·57	3,206	17 6 11	1 6 11	18 13 10	7 10 0	11 3 10	9·68
12	L	D	do.	418·86	4,568	26 3 7	1 18 1	28 1 8	17 3 10	10 17 10	9·85
13	G	D	A.I.S.	309·49	5,054	19 6 10	2 2 1	21 8 11	11 6 3	10 2 8	8·77
14	AB	D	do.	324·87	5,385	20 6 1	2 4 11	22 11 0	12 16 0	9 15 0	9·46
15	F	D	do.	314·77	4,917	19 13 5	2 1 0	21 14 5	11 19 6	9 14 11	9·13
16	H	W	Jersey	315·02	3,465	19 13 9	1 9 0	21 2 9	11 12 11	9 9 10	8·87
17	Y	W	do.	230·68	2,060	14 8 4	0 17 2	15 5 6	6 8 8	8 16 10	6·69
18	AD	D	A.I.S.	312·19	5,360	19 10 3	2 4 8	21 14 11	13 8 11	8 6 0	10·34
19	R	W	Guernsey	314·50	3,735	19 13 2	1 11 2	21 4 4	12 18 10	8 5 6	9·88
20	AA	D	A.I.S.	291·38	4,579	18 4 2	1 18 2	20 2 4	12 1 8	8 0 8	9·95
21	AG	W	Guernsey	292·38	3,911	18 5 5	1 12 7	19 18 0	11 17 11	8 0 1	9·76
22	AF	W	Jersey	249·16	2,720	15 11 3	1 2 8	16 13 11	8 16 3	7 17 8	8·49
23	N	D	Guernsey	306·31	3,509	19 2 11	1 9 3	20 12 2	13 9 1	7 3 1	10·54
24	X	D	A.I.S.	285·69	4,722	17 17 1	1 19 4	19 16 5	14 13 3	5 3 2	12·31
25	Q	D	do.	280·28	5,094	17 10 4	2 2 5	19 12 9	15 14 4	3 18 5	13·45
26	AE	W	Guernsey	264·36	2,781	16 10 5	1 3 2	17 13 7	16 1 5	1 12 2	14·59
27	V	D	A.I.S.	276·71	4,374	17 5 11	1 16 5	19 2 4	17 16 5	1 5 11	15·45
			Average ...	306·99	4,239	19 3 9	1 15 4	20 19 1	10 19 7	9 19 6	8·59

Available Skim Milk = [Total Milk—60 gallons—10%]—120 gallons.

The last table, showing herds in order of merit as profitable milk producers, is headed by Messrs. Bayley Bros.' A.I.S. herd with Mr. W. G. Burges' A.I.S. herd second. Last year these places were reversed.

TABLE 6.

HERDS IN ORDER OF MERIT AS PROFITABLE MILK PRODUCERS.

Place.	Herd.	Breed.	Average Milk per Cow for 9 months.	Value of Whole Milk at 1s. gallon.			Cost of Feed per Cow for 9 months.			Profit per Cow.			Cost of Feed to produce 1 gallon Milk.
			lb.	£	s.	d.	£	s.	d.	£	s.	d.	pence.
1	AC	A.I.S.	8,474	42	7	0	8	14	2	33	12	10	2·47
2	Z	do.	9,100	45	10	0	12	9	10	33	0	2	3·29
3	D	Guernsey	7,443	37	4	0	9	15	4	27	8	8	3·15
4	AB	A.I.S.	7,917	39	12	0	12	16	0	26	16	0	3·88
5	G	do.	7,549	37	15	0	11	6	3	26	8	9	3·59
6	S	Jersey	6,514	32	11	0	6	10	3	26	0	9	2·40
7	AD	A.I.S.	7,889	39	9	0	13	8	11	26	0	1	4 09
8	W	Jersey	6,820	34	2	0	8	7	2	25	14	10	2·94
9	F	A.I.S.	7,397	37	0	0	11	19	6	25	0	6	3·88
10	M	Guernsey	7,890	39	9	0	14	10	2	24	18	10	4·41
11	E	Jersey	5,719	28	12	0	4	10	0	24	2	0	1·89
12	AA	A.I.S.	7,021	35	2	0	12	1	8	23	0	4	4·12
13	U	Guernsey	5,906	29	11	0	7	5	2	22	5	10	2·95
14	O	A.I.S.	7,593	37	19	0	15	14	4	22	4	8	4·97
15	I	Jersey	6,295	31	9	6	10	0	3	21	9	3	3·81
16	X	A.I.S.	7,180	35	18	0	14	13	3	21	4	9	4·90
17	K	do.	5,496	27	10	0	7	10	0	20	0	0	3·27
18	B	Jersey	4,962	24	16	0	5	0	5	19	15	7	2·43
19	AG	Guernsey	6,279	31	8	0	11	17	11	19	10	1	4·55
20	L	Jersey	7,009	35	1	0	17	3	10	17	17	2	5·89
21	R	Guernsey	6,083	30	8	0	12	18	10	17	9	2	5·11
22	H	Jersey	5,783	28	18	0	11	12	11	17	5	1	4·83
23	V	A.I.S.	6,793	33	19	0	17	16	5	16	2	7	6·30
24	AF	Jersey	4,955	24	15	6	8	16	3	15	19	3	4·27
25	N	Guernsey	5,832	29	3	0	13	9	1	15	13	11	5 54
26	Y	Jersey	4,222	21	2	0	6	8	8	14	13	4	3·63
27	AE	Guernsey	5,023	25	2	0	16	1	5	9	0	7	7·68
		Average	6,643	33	4	0	10	19	7	22	4	5	3·97

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